BULLETIN

OF THE

AMERICAN GEOGRAPHICAL SOCIETY.

Vol. XXX **1898.** **No. 1**

RELATIONS OF IRRIGATION TO GEOGRAPHY.

A LECTURE BY

HERBERT M. WILSON,

U. S. Geological Survey.

The relation between Irrigation and Geography seems at first so distant as to render it scarcely evident why a geographic society should be addressed on a purely engineering and agricultural subject. Until within the last decade the half of our great West, a third of the United States, was almost devoid of men and the works of man, outside of limited and widely separated areas in the mountains, where the pursuit of mining flourished. The plains and deserts were uninhabited but for the scattered herds of the ranchman.

All this is rapidly changing; villages are springing up in the desert; the centres of population are moving from the mountains to the plains; numerous roads traverse what was but recently the so-called Great American Desert. Railways and, best of all, canals of life-giving water thread the plains in various directions. All this because we have discovered that where before we had the land, and far from it in the mountains the water, the union of these can transform the former, even in its most forbidding aspects, into a veritable garden spot. Irrigation will, in the next century, entirely change the geography of the great West, and many of the blank spaces on the map will be more densely covered with village names than are similar areas in our East. It seems but proper, therefore, that a geographical society should know something of the art which is producing such stupendous results.

The word "irrigation" may imply to you a condition far more imposing than is intended. In dry weather your neighbor takes a watering pot and sprinkles such of his plants and flowers as he con-

siders most valuable, while, perhaps, with the hose or water barrel he moistens more or less of his garden truck. This is irrigation pure and simple. The only difference between this form and that more generally implied by the word irrigation as used in the arid West is, that in the latter region the application of water to the crops becomes a business by itself, and the farmer and the engineer unite in studying out methods whereby water may be applied in the easiest, least expensive and most certain manner. This is by aid of the action of gravity, and irrigation by natural flow is the result. Ditches are made which lead the water from the source of supply, be it well, reservoir or stream, and they are so aligned and graded that the water shall flow through these and from them into minor channels, and from these again it is led by ploughed or drilled furrows through the cultivated fields.

The mistake is too commonly made of regarding the work of irrigation as a hardship, and the necessity for it as a misfortune. In point of fact the necessity for irrigation and the ability to irrigate make a fortunate combination of circumstances for the agriculturist. The necessity for irrigation implies a warm, dry climate, as that of the arid regions, and this means that the crops are not liable to destruction by sudden, violent storms, nor by the lack of sufficient sunshine, nor by the failure of water supply as sometimes results from dependence upon rainfall. These are the conditions which prevail in the West. All of this fortunate combination of circumstances is not found in the semi-humid region, where the rainfall is usually sufficient, and there is, therefore, not the ever-present sunshine and the immunity from damaging storms; yet here irrigation may fulfil one of its most important functions, that of helping nature over the drought periods.

Even where irrigation is not essential to the production of crops, as in the Central and Southern States, there come occasional years of drought when crops which give promise of the most abundant yield are suddenly injured by an unusual period of dry weather. At such times had the farmer the power to supply the moisture which nature has failed to give, he would be able to tide his crop over the dry period and thus to protect himself against an almost certain loss. Irrigation may thus be regarded as a form of insurance. Every business man insures the contents of his store; why should it not be equally profitable for the man who depends upon the product of the soil, which in itself is dependent upon the moisture supplied it, to put an insurance policy on his crops? The farmer's house or his barn are probably far less frequently destroyed by fire

than are his crops by drought, and yet the loss in the latter case is even more serious than in the former.

For convenience in referring to the lands of the country in irrigation parlance, those of the extreme West are usually called "arid," those between theMississippi Valley and the Rocky Mountains, where the rainfall is nearly sufficient to insure the crops, are spoken of as "semi-humid," and the lands to the east of these are usually referred to as "humid," being those on which the rainfall is sufficient for the protection of crops. Yet this distinction is, to a certain extent, arbitrary, as it depends largely upon the amount of mean annual precipitation. The true distinction between arid and humid regions is dependent rather upon the amount of precipitation during the crop-growing season. In the humid regions in one season out of three the crops are short, the result of unfavorable climatic conditions. The farmer is, consequently, unable to get the maximum product each and every year from his land, and therefore is compelled to cultivate greater areas than he is really able to handle to the best advantage.

Where, as in the arid West, there is an abundance of good soil and plenty of sunshine, and the farmer can apply water just when and as he will, the tilling of the soil becomes a science. It is possible to learn precisely the amount of water required for different crops, and accordingly to produce the maximum output from the minimum areas. As a result, where irrigation is most successfully practised, as in Utah and southern California, the farms are of the smallest size. The average area of an irrigated farm in the State of Utah is twenty-three acres. The average size of a California farm is seventy-three acres, yet the majority of farms in southern California range in cultivated crops only from ten to thirty acres in extent. From such small areas as these farmers are able to produce such abundant yields as to enable them to live with an ease and comfort not known among the smaller farmers of our Eastern States. Another advantage gained by irrigation is in the ability to diversify crops. This is a matter of greatest importance in the Southwest, where the farmers are able to produce but few crops; had they the assurance of sufficient water supply at the time when vitally needed, they might cultivate many of the more valuable fruits and vegetables which are not now found profitable.

Irrigation is not only practised in the arid and semi-humid regions; it is extensively employed in regions of considerable rainfall. In Italy there are about 3,700,000 acres of irrigated lands, and in France a half million of acres. In these countries the annual rain-

fall is nearly as great as in the Eastern States. While the precipitation is ample in Italy and France for the production of ordinary crops, irrigation is practised to increase the yield and offset the consequences of drought. The general impression that irrigation is useful only in arid countries is entirely erroneous. It is such regions as the semi-arid plains of Kansas, Nebraska, Oklahoma and eastern Texas, which are especially in need of irrigation. Here occur usually a series of wet seasons when the rainfall is sufficient to produce abundant crops. At such times immigration is at its maximum, settlement is rapid, and buildings and fences are erected, and the farmers spend their all, as well as mortgage their property, in the hope of gaining a livelihood. Then comes the period of drought. One or two successive seasons of half crops render the inhabitants destitute; they lack the means to pay their debts or purchase food, and were it not for our magnificent transportation facilities and the charity of our people, most woeful famines would devastate these countries. The consequences of drought in the East are not so serious, yet their effect is to render the farmer less prosperous and his life a harder and more laborious one than if he were protected by irrigation.

The history of agriculture by irrigation is as old as the history of the world. History begins in the Valley of the Nile, yet that valley has been irrigated since earliest times. The first agriculture in Europe, Asia and Africa began in arid regions, where irrigation was practised as an essential. In our own country the early Spanish explorers discovered the remains of irrigation works, showing that agriculture by this means was practised by the Aztecs. The remains of their canals and irrigation ditches are to be seen still, in a fair state of preservation, in many parts of the Southwest. The earlier American irrigation works were designed in a haphazard manner by county surveyors, or by railway engineers who possessed little knowledge of the principles of hydraulics underlying the subjects with which they were dealing. Recently the practice of irrigation has developed into a special science, and there has gradually grown up a vast amount of information regarding the branches of engineering most nearly allied to irrigation. As a separate branch of engineering, irrigation first received recognition in India, where a corps of irrigation engineers was first organized about forty years ago, at the time when the British Crown assumed control of that country.

According to the Census Reports the average size of irrigated farms in the United States is sixty-eight acres, and the average

value of the product per acre in 1889 was a little less than $15. This gives no real index to the actual value of some of the crops which are produced by irrigation. Farming with the aid of irrigation is more lucrative—though more expensive—than farming without it. The first cost of land without water supply depends upon the locality. It ranges from $1.25 per acre to from $10 to $25 per acre where the crops and lands are more valuable, as in limited portions of Colorado, Utah and California. The average cost per acre of developing an irrigation plant ranges from $4 in Idaho and Montana, to $10 and $15 in Utah, Colorado and California. The average annual cost of supplying water, per acre, in other words, the average water rental paid by the farmer, ranges from 75 cents to $2, though it is much more expensive than this in some portions of southern California. To these costs must be added those of preparing the land for cultivation, such as clearing, fencing and ditching it. Yet in spite of this apparently large outlay—$5 for land, $10 for irrigation plant, and $2 per annum water rate—lands so made irrigable are at once valued at anywhere from $30 to $100 per acre, while their annual output is frequently as great as these figures. Thus we find that the average annual value of the products per acre of irrigated lands ranges from $15 in the Northwestern States, to $25 or $30 per acre in Utah or Colorado, and up to $500 per acre in California. In the latter region peach, apricot and prune orchards frequently return $100 to $150 per acre. The yield of raisin grapes is often worth from $200 to $250, and of oranges and olives from $300 to $500 per acre.

Let us now examine more carefully the parts which go to make up an irrigation system. Beginning with the rainfall from which the water supply is derived; the mountains in which it is conserved in lakes and gathered in streams to feed the canals; the reservoirs in which it is sometimes necessary to store it; and the main canals which conduct these waters to the irrigable lands; we will then glance at the methods of applying the waters to the soil, at the lands available for irrigation, and at the crops which result from this union.

The true index to the amount of precipitation available for irrigation is not the actual recorded precipitation, but the percentage of this which flows off into the streams and which is known as "run-off." This quantity differs in various portions of the country with the slopes, the flora, the temperature and the soil. A glance at a run-off map of the United States shows in the darker shade of color that portion in which the run-off exceeds 20 inches in depth. This,

it will be observed, is in the eastern and southern portions of the country, in the Cascade regions of Washington and Oregon and in limited areas in the Rocky Mountains. There irrigation is unnecessary because the quantity and distribution of precipitation is sufficient to mature crops. Throughout the desert regions of Arizona, Utah, Nevada, Oregon and Idaho, and in portions of western Kansas, Nebraska and Texas, the run-off is less than two inches. There, not only is precipitation too small to mature crops, but the amount of run-off is too small to furnish supplies for irrigation. The major supplies for irrigation waters in the arid regions are to be derived, as shown by the run-off map, from the great mountains of the Pacific Coast and from the Rocky Mountains in Colorado, Wyoming and Montana, as well as from limited areas in others of the Western States.

One of the best typical irrigation basins of the arid West is that including the drainage of the Arkansas River in Colorado. Your attention is called to it because it illustrates well how use may be made of all the waters of a drainage basin for the irrigation of its agricultural lands. The Arkansas River rises among great mountain peaks, ranging from 12,000 to 14,000 feet in height, capped with perpetual snow. The lower foothill slopes to the east of the mountains are irregular in shape, covered with a scattered growth of scrubby timber, and furnish excellent grazing for cattle. Among these foothills are numerous sites suitable for the construction of reservoirs, in which to store the surplus water that comes from the higher mountains and retain it until needed for irrigation during the cropping season. To the eastward of the foothills is a great area of gently rolling land, well suited for the raising of all crops which will grow in the climate of Colorado. Through this the Arkansas and its tributaries have eroded deep channels, and it is therefore necessary in order to conduct the irrigation waters to the lands above these, to divert the waters of the river by canals heading in the foothills and lead them on suitable gradients to the plains below.

If we observe the character of the higher mountains, on which the rainfall is great and which furnish the ultimate source of supply of irrigation waters, the steepness of the barren rocky slopes shows clearly that the greater percentage of the precipitation in such a region runs off to the streams, as it would have no opportunity to lie quietly and evaporate, or percolate into the ground. The little streams which gather the water in these mountains connect together in rushing mountain brooks flowing over steep and

pebbly beds, and these emerge from the mountains on to the foot hill slopes in broad and shallow rivers, the waters of which, if not diverted into canals for irrigation at these points, quickly sink into the ground or are evaporated, leaving the river beds practically dry but a few miles further on. An examination of a diagram showing the discharge of such a river, the Arkansas for example, gives an idea of the irregularity of its flow. From January to April its volume is practically uniform, as it is from August to December, the discharge being approximately 500 cubic feet per second, but between May and August, the period in which the snows are melting in the mountains under the influence of warm rains, the volume of the river rapidly rises to a maximum at the end of June of 4,500 cubic feet per second, nine times that which it normally has. It is this great volume of water which it is desirable to conserve in storage reservoirs, otherwise it rushes off in floods to the ocean and is lost to irrigation. It is to preserve this water until it is wanted by irrigators that storage reservoirs are built.

On the flat plains country to the east of the Rocky Mountains, in Kansas, Oklahoma, etc., the occasional precipitation either sinks into the soil and is thus lost to agriculture, or it occurs in violent storms of short duration and rushes as a flood over the entire surface of the land, falling into the streamways over steep banks which are eroded by its action. At times the volume of this surface run-off is so great as to produce temporary waterfalls of giant proportions, and it can be readily realized that such falls rapidly wash away the banks of the ordinarily dry streams.

Let us glance now at the character of the irrigable lands. In western Kansas, Nebraska and Texas we find a flat prairie land which produces an abundant natural growth of grass, but here the rainfall is insufficient or is so poorly distributed as to make agricultural pursuits hazardous without the aid of irrigation. Here the soil is deep and fertile, water alone being required to make it productive. In New Mexico we find rolling plains, the slopes covered with short bunch grass, juniper bushes and sage brush, the surface practically barren of vegetation and exposing a sandy or loamy, barren soil. This is among the most fertile of the soils of our country when water is applied to it, and is capable of producing the finest varieties of all valuable fruits and vegetables. In Arizona, Utah, Idaho and Nevada, the best agricultural lands are the great level, sandy and barren plains covered with occasional scattered bunches of sage brush. Here rainfall is entirely inadequate to the maturing of crops, but when artificially watered this soil is equally

as productive as that found in other portions of the arid regions. An idea of the fertility of this soil may be readily gained by a glance at some of the thickets of cacti which flourish in all the southern portions of this region, plants which mature in the most barren country and without rain or other watering.

In addition to the surface water supplies, those derived from run-off from streams or conserved in storage reservoirs, there are large volumes of sub-surface water ; water which has filtered or percolated into the ground, whence it may be got by digging wells or boring artesian wells. In the West are some great artesian basins, notably those of the Dakotas and Texas; the Carson Valley of Nevada, and the valleys of southern California. Here numerous artesian wells are bored and furnish such volumes of water as provide for the irrigation of considerable areas of land. As these wells flow continuously, while irrigation is practised intermittently, it is therefore found advantageous to build about them storage tanks or reservoirs in which the water may be conserved or collected until wanted in irrigation. Some of these storage reservoirs are made most beautiful, especially in southern California, by planting about them palms, lilies and other tropical plants which flourish luxuriantly under the genial sunshine of that clime and the beneficent moisture of the artesian waters. Others of these reservoirs are quite extensive and are supplied by large wells, or numbers of wells, and have been so beautified and arranged as to produce picturesque lakes.

Irrigation, as originally practised in Asiatic countries, consisted chiefly in pumping water out of wells and pouring it into small ditches which carried it to the irrigated fields, or more expeditiously in bailing it, as it is called, by two men swinging a wicker basket between them in such a manner as to toss the water from the stream into the irrigating ditch. Again, it is raised from wells by the "shadoof" or "pakota," which is simply our old-fashioned well-sweep, several of these being sometimes arranged in a series of steps one above the other, the water being lifted from the lower level and emptied into a trough above, whence it is raised by the next higher well-sweep through a further elevation until it ultimately reaches the ditches which conduct it to the fields.

Pumping is also practised in our own country, especially in the plains region, where there is a constant and regular wind supply, and well water or water from shallow streams is raised by various forms of windmills. Sometimes by the old-fashioned windmill, which lifts the water from its lower level into ditches which flow above the surface. More commonly we find modern windmills, and

these are provided with storage reservoirs as are artesian wells, so that the mill may be run whenever the wind suffices, and store up water for use when wanted in irrigation. Again, on flowing streams water wheels are employed to pump a portion of the volume used in producing their power to higher levels for irrigation. Still again, steam pumps, not infrequently of large size, lift water continuously to storage reservoirs, whence it is conducted to the irrigated fields.

And now we turn to the main sources of supply for irrigation, the surface waters. In the mountains, that volume of water which flows off during flood seasons is caught in great reservoirs or artificial lakes where it is stored until required for irrigation, and then it is liberated and flows for many miles down the mountain streams until it reaches the neighborhood of the irrigable lands, where it is diverted in ditches. A glance at one of the localities in which such reservoirs are constructed gives us an idea of the kind of mountain valley best suited to their uses. A great dam is built across the confining hill slopes at the foot of the valley, thus forming an artificial lake which will store large volumes of flood water. The building of such a mountain dam is an interesting process. It may be constructed of earth or of substantial masonry, or, as is not uncommon in the higher and less accessible mountain region where labor and transportation are expensive, a cribwork is constructed of logs, cut in the immediate neighborhood and weighted down with heavy rocks to hold them in place. One of the most magnificent and substantial storage reservoirs in the West is that formed by the Sweetwater dam in southern California, a massive masonry structure which bars the rocky outlet of a broad valley. Great care and skill must be exercised in constructing such a dam, for be the engineer's calculations of flood volume ever so liberal, a flood may occur of such volume as to fill the reservoir and top the dam, as in the case of the Sweetwater dam, but fortunately without causing its rupture. In building a masonry dam to withstand such hydraulic forces the foundations must be dug deep and well, so that the masonry may rest on the most substantial and homogeneous rock, far below the natural surface of the ground.

The waters stored in these mountain valleys are conducted sometimes directly by ditches to the irrigable lands, at other times are passed back into streams and again diverted therefrom lower down. In the valley of the Arkansas in Colorado are numerous irrigating ditches diverted from that stream. Some of the flood waters of the stream are conserved in the mountains in reservoirs, whence they are liberated when needed, and flow for many

miles down the Arkansas to the neighborhood of Pueblo, where the stream leaves the mountains. From there on down the stream numerous ditches are diverted, which climb in long and tortuous curves away from the river banks until they reach the upper and more level plains lands. From these ditches are then taken other and smaller channels which irrigate the fields, or, not uncommonly, they discharge much of their volume into reservoirs constructed on the plains lands where it is stored until it is wanted for irrigation; so that a double system of storage is practised, that of the mountain waters which are retained in time of flood, that from ditches which are permitted to run full at all times of the year, though the waters which they carry are utilized but occasionally during the summer. The plains reservoirs are often quite numerous, dotting the uplands in all directions. They are natural hollows or lakes on the plains, ordinarily dry or filled with alkali water, but when utilized as reservoirs filled with good, fresh, river water. A cheap earth dam is constructed at the outlet of these, supplemented by a cut which reaches to the level of the bed, and thus enables a large volume to be retained within them and allows this to be easily withdrawn. Some of the plains reservoirs are quite picturesque, forming pretty lakes in the landscape, and often they are of such dimensions as to be utilized as fish ponds and enjoyed by pleasure seekers in row and sail boats.

The waters which flow through the great rivers of the plains can only be diverted from these by means of great ditches, weirs and dams of expensive and difficult construction, built to withstand the eroding action of the immense volumes of water which assail them. The Arizona dam, on the Salt River in Arizona, has had to withstand the erosive action of floods greater than the discharge of the Potomac or Hudson or even that of the Mississippi River, yet in ordinary seasons the discharge from this stream is so small as to scarcely fill the canals which are diverted from it. These dams are usually built at the points at which the streams debouch from the hills to the plains. At one end of such a dam heads the supply canal, which is usually constructed at great expense by difficult excavation in the rocky slopes of the mountains, until it finally emerges from their confining walls and finds its way by winding curves through the irrigable lands of the plains. In order to control the admission of the river water into the canals at the point of stoppage of its flow by the dam, there must be built in the head of the canal great regulating works or gates, which may be lowered or raised according to the amount of water which it is desirable to

permit to enter the canal. An excellent example of the relation of the head gates to the canal, the supplying stream and the dam, is that furnished by the Folsom canal, diverted from the American River in California.

The diversion line, as it is called, of some of these canals—by which is meant that upper portion of its line which is built merely to get the water from the river to irrigable lands, and not that portion which is doing active work in irrigating the fields—is usually the most difficult and expensive portion of the canal to build, as it has to cut through rocky slopes, tunnel ridges and be carried across ravines in flumes or pipes. The construction of such canals is an interesting and expensive operation according to its size. It may be so small that the excavation can be made by hand. In California not uncommonly the hydraulic monitor is employed in excavating the canal line and water itself is utilized in digging the channel through which water is later to flow. One of the greatest canals in the country, the New York Canal in Idaho, was constructed rapidly and with a large force of men, working with modern tools, ploughs, scrapers and excavators. In flat valley country, as in the Sacramento valley in California, canals have been simply and cheaply constructed by great steam dredging machines, the work being executed on a scale commensurate with its magnitude.

Some of the cuts which must be made in excavating these canals are deep and difficult, as that on the Payette canal in Idaho. Again, the water is conducted around rocky slopes in wooden flumes built against the rock walls; at other times, that its grade may be maintained, it is carried across creeks and ravines in similar flumes, and even after it reaches the level and more gently sloping irrigable lands it has to be carried across side drainage lines in flumes of similar construction. The building of such flumes is a work of no mean magnitude, even when they are made throughout of wooden timbers, as is the more common practice; while others have been most substantially constructed, as those of the Santa Ana Canal, not of wood but of iron, resting on iron piers, the iron or steel framing being lined with wood. In India, where are to be found the greatest of all irrigation works, these have usually, in accordance with British methods, been built in the most substantial manner, the flumes or aqueducts being of massive masonry. The largest of these in the world is that in which the Ganges Canal is carried across the Solani River; the canal at this point being 270 feet in width on top and ten feet in depth, a stream which far exceeds in magnitude the Erie canal and in fact many of the rivers of our country.

Instead of in flumes, water is sometimes carried across ravines in what are called "inverted siphons," or more properly "pressure pipes," which are wooden pipes constructed much like a continuous barrel, bound with iron hoops, and through these the water flows down the hill-slopes on one side and up the other; the down-stream end being necessarily lower than the upper or inlet end that the pressure from the latter may be sufficient to force the water through the pipe. Again, the line of these diversion canals may be blocked by ridges which must be tunneled, and in some cases there occur, as on the Bear River Canal in Utah, two or three such tunnels following each other in quick succession.

Finally, the diversion line emerges from the confining hills, and the canal is now a broad and limpid stream, well graded, which meanders slowly through the gently undulating plains which are to be irrigated. Sometimes the slopes are so even that the canal may be carried as a direct line, a beautiful, straight, silver stream, through the immense valley. In the banks of such canals are built, at occasional intervals, gates of wood or masonry, through which the water can be passed into smaller or minor canals and ditches which lead it to the irrigable fields, and from these it is discharged into still smaller channels which distribute it over the land. Some of these smaller irrigating ditches are excavated at considerable expense, and those taken from the larger canals are often works of quite as great magnitude as the main canals taken from smaller streams. As these canals pass through the plains, it not infrequently happens that the slopes of the plain are greater than the permissible slopes of the canal, for if the slope of the canal were too great it would erode its banks; there are, therefore, at intervals in these canals, falls by which the water is lowered with a single drop from one level to another, and it is usually just above such falls that the branch canals are diverted. In southern California, where water is more valuable than in the plains region, because of its scarcity and the value of the crops it produces, it is not allowed to flow through channels excavated in the earth, as much of its volume would be dissipated by percolation into the ground and by evaporation from the surface. Here it is conducted through narrow and deep channels lined with masonry to prevent its loss.

Ultimately these minor ditches reach the fields, and there the water is again checked by regulating gates which turn it in greater or less volume, as may be desired, into the slightly smaller channels from which it is flowed over the land. The processes of irrigating the land from these minor channels vary according to the crop, the

soil and the slope of the land. In some portions of the West, especially in Wyoming, Montana and the mountains of Colorado, where water is comparatively abundant and the climate such that hay and grain crops can be successfully produced, water is handled wastefully by being flowed over the entire surface of the field at each irrigation. In such cases a break is made in the bank of the ditch whence the water is conducted and coaxed by the use of a hoe in such manner as to lead it in a uniform sheet over the entire meadow. After it has flowed for perhaps a day it is stopped off and permitted to soak into the soil. Two or three, perhaps four such irrigations in a season, are sufficient to produce as many heavy crops of hay. Again, instead of breaking the banks of the irrigating ditches, a more common practice is to use a "check" or "stop" of some kind in the ditch. Not infrequently a curtain of canvas, weighted with a clod of earth, is dropped into the ditch, thus forcing the water back over its banks whence it floods the grain fields.

The more effective way in which to use water in irrigating is by flowing it through drill rows or furrows, ploughed sometimes with a single cultivator, but occasionally on a larger scale with great steam gang-ploughs. In these furrows or drill rows are planted the various crops, and through them flows the water which moistens them. It is not possible to irrigate grain or hay in this way, because the rough, furrowed surface would prevent its being mowed with machinery; so that hay or grain crops, where intelligently handled, are irrigated through shallow rows made by the drilling machine which sows the seed, and these do not cause the surface of the ground to be any more irregular than they do in the East, where irrigation is not practised.

Potatoes, cabbages, corn and similar crops, however, are planted in deep-furrowed rows, made by ploughing the land with a plough the share of which is V-shaped, and does not turn the earth in one, but in both directions. Crops are planted on the intervening ridges, and through the furrows flows the irrigating fluid. Fruit crops are sometimes irrigated by running several rows of shallow furrows between the trees; through these pass small streams of water which, flowing rapidly, percolate well into the ground and moisten the roots of the trees from a distance, and deeply, thus producing the most desirable effect, that nearly approaching a steady moistening by a soaking rain. A less satisfactory, but quite common way of irrigating trees, is by running a couple of ditches, one on either side of the trees and nearer to them, and from these the water seeps into the ground and about the roots. On steep

hillsides the ground is levelled off in terraces, as in the foothills of California, and the water is flowed through ditches on the upper terrace, settling in basins constructed about each tree, and when these basins are full and the water has stood in them long enough to soak the ground it is drawn off into the next terrace and series of basins below it, and so it flows on down hill, watering terrace after terrace in its progress.

The products of irrigation unquestionably exceed in amount and quality those produced under the vicissitudes of natural conditions. Sunshine is ever present, the soil chosen is always the best, water is applied just when wanted, and the result is to bring about practically such conditions as exist in a hothouse or conservatory. Such a crop of potatoes as is ordinarily gathered in the irrigated fields of the arid West cannot be harvested in the humid East. The cabbage crops of the same region are equally luxuriant and abundant. In irrigated cornfields the stalks far exceed in height and in verdure those of unirrigated regions, while an average of two or three ears of enormous size is produced on each stalk. The crop of an irrigated wheat field, where the water is intelligently handled, may, like all other irrigated crops, run to leaf or to grain, according to its treatment. Where properly handled, the leaf and stalk, in other words, straw, will be least in amount and the grain greatest.

The art of agriculture by irrigation is quite as different from the art of agriculture in humid regions, as is the act of irrigating land different from the act of cultivating without irrigation. Abundant as are the grain and vegetable crops of irrigated fields, the hay crops are equally luxuriant, but probably none flourish with such luxuriance under irrigation as do the grape and citrus fruits. I can conceive no more beautiful sight than a well-irrigated and well-laid-out vineyard, such as may be seen extending for miles in southern California; and no more attractive objects than the raisin, prune or apricot drying beds of a California farm at the close of the season.

In conclusion, a brief review of the processes of irrigation, and the wonderful transformations wrought by it, may be got from a study of a typical vineyard in Kern Valley, California. The case here chosen represents a period of four months; in March the field was ploughed and the ditch excavated; in May the vines were sprouting from the cutting, and by July they have attained full growth and are producing the first scanty crop of grapes. Thus irrigation, as by magic, gives constantly changing views, and our geographies must in part be rewritten to keep pace with the marvellous development of our great, arid West.

FROM CAIRO TO BENI-HASSAN.

BY

D. CADY EATON.

About ten miles south of the pyramids of Gizeh is Sakkara, and about three miles south of Sakkara is Dashur. Sakkara and Dashur are at the edge of the desert. Between them and the Nile is supposed to have been the heart of the great city Memphis, whose limits are unknown. From north of the pyramids of Gizeh to south of Dashur stretched the necropolis of Memphis. The ruins of tombs and pyramids are everywhere. Most of the abodes of the dead were ransacked and plundered centuries ago. Now and then one is found intact and as it was sealed up by surviving relatives three or four thousand years before the Christian era. The tombs of Ti, Pthahotep and Sabu were discovered during the present century. The tomb of Mera was discovered in 1893. Two years ago three tombs of princesses of the Aménema family of the XII. dynasty were also discovered. Over three hundred tombs were excavated by Mariette. Active search is still kept up. Any day news may come of new discoveries which may shed light on vexed questions and start new ones.

The best way to visit Sakkara is in a sand cart from Gizeh. These carts, which are quite comfortable, are made with very broad wooden tires which prevent the wheels from sinking into the sand. With a good donkey harnessed to the cart you can make the distance in about two hours.

Before examining tombs, a brief statement of the ideas held by the ancient Egyptians about death and the dead may serve as introduction. The poor seem to have been regarded as cattle. A shallow trench and a scant covering of sand sufficed for the burial of their soulless bodies. But the rich and the mighty were immortal.

Generically stated, the Egyptians believed that at death body and soul were separated, to be reunited at some distant time; and that the body must be preserved so as to make possible the reunion. No satisfactory idea of the details of the processes can be had. Documents are few; those who have studied them do not agree. Some points, however, seem partially established. The soul, or living principle, or whatever you choose to call it, was composed

of several parts. First in importance was the "Ka" or double. Exactly what the "Ka" was is obscure. When a king is represented, his "Ka" may be represented also; as in a relief, in the temple of Der-el-Bahri in the neighborhood of Thebes, where Queen Hatshepsu, who was an advanced woman and always appeared in male attire, is making offerings. Immediately behind her is her "Ka," resembling her in form and feature, but of only about half her size. Then again the "Ka" is represented simply by a two-armed staff bearing another staff, as in a relief in the temple of Abu Simbel near the second cataract. The relief represents the great Ramses II. cutting off the heads of a handful of his enemies. In front of, and facing him, is the hawk-headed god Horus offering him something better to cut off heads with. Back of him is his "Ka," symbolized by a two-armed standard surmounted by a hawk crowned with the double crown of upper and lower Egypt. In one of its hands the "Ka" standard holds a staff which is surmounted by a representation of the King bearing on its head the upraised arms which form the "Ka" sign. The double crown on the hawk's head looks for all the world like a champagne bottle in a champagne cooler. The champagne bottle, which is always white, is the crown of upper Egypt; the cooler, which is red, is the crown of lower Egypt.

That ideas about the "Ka" were vague is evident from a relief in the temple of Amenophis III., at Soleb, away up the river, in the centre of Nubia, where nobody goes nowadays. Amenophis, or Amunoph III., was of the XVIIIth dynasty; that is, he lived, flourished and reigned about 1500 years before Christ. He was a great conqueror, and annexed Nubia to Egypt. In the relief, according to the hieroglyphic inscription, he is represented making an offering to his "Ka," that is, to himself deified, as if no divinity could be superior to his own personality. The "Ka" replies: "I give thee all life, all stability, all power, all health," &c., &c. Such instances of inordinate self-adulation and unblushing self-adoration are common to every part of Egypt and to every dynasty. Humility and self-abnegation were unknown qualities in Egyptian royal families.

A relief in the temple of Amenophis III., at Luxor, shows the "Ka" in another form. The scene represents Amenophis, when a child, presented with his "Ka" to the god Amen Ra, in the first place by the hawk-headed Horus, or Harmachis, and in the second place by two lesser divinities, who represent the River Nile. Here the infant and its "Ka" are precisely alike. Children are almost

always represented with a finger in the mouth, and a thick, curled lock of hair over the ear.

The effort to make of the "Ka," or of any other Egyptian idea, a complete and logical entity for the understanding and acceptance of the modern mind may amuse and interest psychologists, but the task should not be attempted by sensible, everyday people. A very old belief about the "Ka" was that after a man's death his statue attracted his "Ka," and the more statues there were, the greater the "Ka" powei, or the number of "Kas," attracted. This accounts for the great number of statues of a king found in his temple. The gods also had "Kas." The great god Ra had fourteen "Kas." The "Ka" is a puzzle even to the erudite.

Next in importance to the "Ka" was the "Ab," or heart, regarded as the principle, or source, of human life. At death the "Ab" returned to heaven, its source; and stayed there till the deceased reached the hall of judgment in the lower world. There it appeared as a witness for, or against, him. If the verdict were favorable, the "Ab" rejoined the deceased, who then became immortal. In order that some kind of life be preserved in the mummy, the mummy must be provided with a substitute for the heart,—with a provisional heart. This provisional heart was a large, artificial scarab. The underside was flat, and on it was engraved a prayer, or invocation, to the heart itself, beseeching it to be kind and merciful when it appeared in the hall of judgment.

Another immortal ingredient was the "Ba," or spirit, a conception nearly corresponding to our idea of the soul. It was represented at times as a human-headed bird; at other times by a ram-headed scarab. The "Ba" is often perched on top of the mummy, as if bidding it good-bye before departing for the home of the gods. The "Ba" could, and often did, revisit the mummy, and on those occasions expected to find offerings of food and drink for its acceptance and use. The representation of a "Ba" flying down the shaft leading to the underground tomb of the mummy, for the purpose of making it a visit, is very frequent, and is almost always found in the copies of the Book of the Dead. The notion of representing the soul as a bird or as a child, with or without wings, is common to many nations, and is not repulsive to Christianity.

There were two other entities which made up the immortal man: The "Khaib," or shadow, represented by a fan; and the "Sahu," which seems to have been a species of immortal outline or exterior. It is no wonder that the poor Egyptian, with so many things inside of him, should have become confused when attempting to discrimi-

nate and describe. That modern investigators share his confusion is most natural. The Book of the Dead, in which these various components appear, and which is the source of information on the subject, is most confusing.

Maspero, after having devoted years to its study, still frankly confesses that he does not understand it.

There was still another thing, and a very important thing, called Osiris. The Osiris corresponds to our ghost and the Greek shade. The Osiris is the thing which goes below and is subjected to the trials of the Egyptian purgatory. The Osiris resembles the deceased and retains his character and disposition. Osiris is, at the same time, the name of the great sun god, husband of Isis and father of Horus, who was killed by his wicked brother and thereafter became the king of the next world. The fact that each shade that appears before him is called by his name adds still further to the difficulty of obtaining clear views of Egyptian thanatology.

There has lately appeared a small book by Professor Wiedemann, of the University of Bonn, in which the Egyptian doctrine of immortality is made as clear as, I suppose, it can be made. At all events, I have accepted his views in preference to those of other more elaborate and more pretentious authors. Read the book—it is in every library,—and has been translated into many languages.

Egyptian tombs may be partially, but not strictly, divided into three classes,—the pyramid, the mastába, and the gallery. Of the pyramid you are supposed to have been informed at Cairo. Next comes the mastába.

That the mastába had its origin in the pile of stones which primitive man threw up over the grave of a chief may be accepted. The word mastába is modern Arabic, and means bench. The word was applied by the Arabs on account of the long, low and comparatively narrow form of the buildings. The mastába consisted of a quadrangular mass of stones and rubbish enclosed within hewn walls, and covered with a pavement of hewn stones. Mastábas vary in length from 25 to 150 feet, with proportionate breadth, and are from 10 to 25 feet high. The walls incline slightly on all sides. This has caused some investigators to suppose that mastábas were the beginning, the cores, of pyramids. From the top of the mastába down through it to the rock on which it was founded, and then down through the rock, was a square or oblong shaft reaching from 20 to 75 feet. Sometimes there were two shafts. At the bottom of the shaft was a narrow passageway, which soon enlarged and expanded into the sepulchre chamber, where the sarcophagus was

placed. When the funeral rites were finished, the entrance to the passageway was sealed by a huge stone; the shaft was filled up with stones and rubbish; its mouth was closed by a slab not to be distinguished from the other slabs about it, and the dead was left forever to the tender mercies of its "Ka," its "Ab," its "Ba," and its other immortal compounds. Most mastábas have their longer axis running from north to south. Some are solid throughout and have nothing to indicate the use to which they are put, but most have, at least, a high, narrow and shallow opening in the east side near the north, terminating with the semblance of a door. This door represents the entrance to the infernal regions, through which the deceased has passed, and through which no living being can follow. In the larger and finer mastábas there are, in addition, vestibules, supported by square columns, without plinth or abacus, and at the bottom of the vestibule a door leading to one or more chambers. No exact plan is followed. The vestibule and chambers are sometimes on the south side, more often on the east side, generally on the north side, never on the west side. The mastábas of the first three dynasties have but one chamber. Those of the fourth and fifth dynasties may have many. After the sixth dynasty mastábas disappear and do not recur in Egyptian history. Mastábas of the very earliest date are supposed to have borne no inscriptions or reliefs, but nearly all so far discovered have, at least, the representation of the gates of the under world, while mastábas of the fourth and fifth dynasties are rich in inscriptions and in diversified ornament.

Apart from the main chamber, where the family met for funereal services and banquets, the mastába contained another and a small chamber called a sirdab, which only communicated with the other chamber by a narrow slit high up in the wall. The sirdab was the dwelling of the "Ka." It contained statues of the deceased, which were supposed to be filled with the essence of his "Ka," and through the slit was wafted to the "Ka" the fragrance of offerings made in the larger chamber.

The exterior narrow opening already mentioned was for the exclusive entrance and departure of the "Ab," or soul, when it chose to visit the mummy. The doors to the lower world were only attached to this opening when it was the only opening in the mastába.

When the traveller gets back to the boat at Bedrashen he will probably be so overcome with fatigue, heat and dust that even the slender comforts of a Cook steamboat will seem paradisiacal. After

being thoroughly washed, reclothed, fed and restored to a right mind, he may be in condition to look over those pages of the Paris "Illustration," wherein a clever French artist has depicted triumphs of excavating achieved by M. de Morgan, who is at one and the same time the head of the French School of Archæology at Cairo, and the chief of the governmental department of antiquities; at least, that is about as well as his position can be described amid the complications of Egyptian government. Though the French politically have been supplanted by the English, they seem archæologically still to be on top.

M. de Morgan, in pursuing his investigation, hit upon the clever scheme of being governed by soil indications. He first made repeated borings, so as to become acquainted with the character of the soil at different depths. If, then, he found on the surface of the ground soil that was not surface soil, he followed it like a trail to the spot where the trail stopped. There, he surmised, was the spot where there had been digging for space for tombs, and where he must dig to rediscover the tombs. The scheme has worked admirably. He first applied his method during the early spring of 1894. His success has been wonderful. Many royal tombs have been discovered, and priceless additions have been made to the collection of jewels at the Gizeh Museum.

As the steamboats on the Nile do not steam at night, owing to the intricacies of the current and to shifting sandbars, it takes two days to reach Beni Hassan, the next regular stopping place.

The tombs of Beni Hassan, high up on the hillsides, are kept clean and in good order, and are part of the regular Nile show. They are neither mastábas, nor galleries. They have the sepulchral pits of the mastábas, but in place of the mastába itself is substituted a subterranean temple.

Beni Hassan is about 230 miles from Cairo. During most of the distance the mountains come up closely to the east bank of the Nile, but are from five to twenty miles away from the west bank, leaving a belt of most fertile soil. Here are the sugar plantations. A most odd Egyptian experience is to see rising on the site of a town of Ramses II. the lofty tower of a modern sugar refinery, belching forth its thick, black smoke to the confusion of meditations of the past. During the two days of steaming and casual stopping, you have ample time to examine the natives, who flock to the banks where your boat ties up; and to meditate upon their past, present and future. The regeneration of a fallen race is a topic of philanthropic theory, but history furnishes no instance of its accomplishment.

Races advance and then stop at a barrier, over which they cannot carry their peculiarities. Other races, far below them at the start, leap the barrier and pass on to some other barrier, which in turn stops them. In all history there is no one instance of a race recovering lost prestige and power. The torch of civilization must be held high, grasped firmly and ever advanced. If, in the history of the world, there was a time when such a creature as the present Egyptian was supreme in human rank, man, from our point of view, must have been a very poor and contemptible being. Modern Egyptians are extremely low in the scale of humanity. They gather about in helpless groups. They stare with far less intelligence than their donkeys. They squat. They allow themselves to be beaten with sticks, and to be driven about like dogs. When stirred to activity, their activities are vile. If any one succeed in accumulating money, it is used in the gratification of the lowest and most disgusting sensuality. Should England withdraw from Egypt the presence and weight of her authority, the country would lapse into barbarism and be as unsafe as the fighting ground of Kurd and Armenian. If the world is to be Christianized, it will be by the flowing of Christian races over its surface, and by the disappearance of those races which can neither apprehend nor embrace Christian principles. Of all enemies of Christian progress, the Mussulman is the most stolid and the most bitter. To convert him is as hopeless a task as to teach a tiger to use a napkin.

The women of the villages are not a whit more attractive than the men. The ordinary dress of the men is a cotton shirt, originally white; over it another cotton shirt, originally blue, and a white turban. The women are generally satisfied with one shirt, and a piece of cotton cloth, which is occasionally drawn over the head as a shawl. They are ignorant of stockings, stays and underclothes, and share their liege-lords' ignorance of cleanliness, modesty, morals and manners. Carrying water from the river is one of the labors they share with their mates. Their wretched fate seems to deprive them of even the solace of gossip. In villages of a thousand, or more, inhabitants, you may not find a house that is not made of Nile mud, or that has more than one room and one story; nor a street that is not a crooked rivulet of filth oozing down to the Nile. How people can survive a single summer of such existence is one of the mysteries of Egyptian Providence.

Sometimes the monotony of the voyage is relieved by the sight of a dahabiyeh, in which some English lord, or American millionaire, may be leisurely and most pleasantly doing the Nile. To a

party with cash, patience and leisure, life on a dahabiyeh, with well chosen guests, must be delightful. The drawback is, that you are dependent on the wind for locomotion, and may be becalmed for a month. Still, during the winter months, the winds generally blow from the north to help you up the Nile; and when once up, you may float down with the current.

On the third day after leaving Bedrashen, you are made aware that you are approaching Beni Hassan, by the assemblage of donkeys and donkey boys on the bank. The donkeys of Beni Hassan are well up in the rank of faithful and intelligent donkeys, and the Arab boys are not so bad as anticipated. The further the Arab is removed from Cairo, and from the influences of modern European civilization, the more tractable he seems to be. At Luxor, Assuan, and other large places where there are modern hotels, vice-consuls and American schools, the Arab is nearly as bad as he is in and about Cairo. Where he lives in the midst of his primitive filth and ignorance, he is a quiet beast till aroused by cupidity or revenge. Then he is like all other wild animals, and must be held in absolute subjection by fear and force.

To thoroughly explore and thoroughly understand the tombs of Beni Hassan, would take lengths of time and lengths of study. They were visited by the earliest explorers. Numbers of explorers have written about them, and almost every explorer has advanced ideas which subsequent explorers combat and demolish.

The tombs are excavated in the rocky hills which shut in the Nile Valley on the east, are less than two hundred feet above the Nile level, and are about two and a half miles northeast of the village of Beni Hassan, where the steamer stops. A stratum where the limestone was compact was selected. Its face was cut down, and cut away, so as to present a perpendicular surface, and at the same time to afford a horizontal platform of approach. Then digging commenced from the horizontal platform. Over thirty tombs have been discovered and cleaned out. The inscriptions on some of them are of the 12th dynasty,—that is, between about two and three thousand years before Christ. According to Biblical chronology, Joseph died in Egypt in 1635 B. C. So these inscriptions may be 1,500 years older than Joseph. Critics have hastily concluded that the tombs are of the dates of the inscriptions. For all the evidence at hand, these caves may have existed for other thousands of years before the notables of the 12th dynasty utilized them as tombs. They may have been the residences of primitive man at the geological period when the River Nile filled all the val-

ley below and reached up to the base of the hill where they are dug.

After being hurried through these tombs you long to return with time enough to examine from some point of view which even a rapid survey cannot fail to suggest. If the original caves were enlarged at subsequent periods, there must be indices, as in a Gothic cathedral, to distinguish the work of one period from the work of another. The nearness to one another of the adjoining walls of any two of the larger tombs, in comparison with the greater distance between the smaller tombs, may suggest the idea that the nearness, in the first instance, is the result of a broader enlargement of the original excavations.

Thirty-nine tombs have been investigated. There may be many more both to the north and to the south, not yet discovered, and there may be other rows in other strata of the hill.

Tomb No. 13 is supposed to be the oldest, and tomb No. 4 the newest. Most of the smaller tombs are without pictures or hieroglyphics. Tomb No. 2 has an inscription of the date of the 43d year of Usertesan I., who was the first king of the 12th dynasty, and reigned, according to Mariette, 3604 years before Christ. Tomb No. 3 bears the date of the 6th year of his successor, Usertesan II. These tombs take us back a thousand years before the accepted date of Noah and his ark, to the days of Mahabaled, Jared and Enoch.

The pictures and inscriptions in all the tombs are so very much alike that it is hardly necessary to examine more than two or three of the tombs, unless you be an archæologist in quest of discoveries.

Tomb No. 2 is one of the most attractive. It is one of the largest. It has a fixed date, and its pictures and inscriptions are in a fair state of preservation. No. 2 is the tomb of Aménemhat, whose name was so long and so hard to pronounce, even by contemporary Egyptians, that it was frequently shortened to Ameni. According to the inscriptions, he was every sort of a thing. In the first place, he was governor of that province of Egypt which was called the Oryx nome, and in which these tombs are located. Egypt was divided into nomes, or provinces, of which the names and the boundaries varied. Oryx means a wild goat. In addition to being the governor of the province, Ameni was, as the hieroglyphics are translated, a double prince, treasurer of the king of lower Egypt, true royal acquaintance of the king, regulator of thrones, overseer of horns, hoofs, feathers and minerals; superintendent of all things which heaven gives and earth produces; chief

captain of the hosts, priest of Shu, Tefnut, Horus and Anubis; set over the mysteries of divine words; master of all the tunics, etc., etc., etc., etc. In fact, according to Ameni's account of himself, there could hardly have been space, occupation, dignity or power left in Egypt for any other functionary. But all inscriptions in all tombs are equally laudatory, self-complaisant and comprehensive.

Ameni's tomb may be said to be divided into three parts: The main hall, which is about forty feet square; the small sanctuary back of it, and the portico in front of it. In front of the portico there was originally a closed space. This has almost entirely disappeared. There are a few stones left, which appear as if they may have formed parts of walls. The portico was supported by two fluted columns. The roof of the main hall was supported by four. In this tomb there are two shafts. In some of the tombs there are as many as six. In tomb No. 28 there are eight. In the sanctuary is the mutilated statue of Ameni, seated on a throne, and flanked by two small statues: the one on his right, of his wife; the one on his left, of his mother. The sanctuary answers to the sirdab of the mastába. The ceiling of the portico was arched transversely, while the ceiling of the main chamber was divided into three longitudinal arches. So the Egyptians of this remote period must have had some knowledge of the arch.

When you enter you find yourself face to face with one of the great and still unsolved questions of Egyptology. What difference is there between the fluted columns of this temple and the Doric columns of early Greek architecture? Is there any generic difference? But these columns must have preceded Doric columns by at least ten and, quite probably, twenty centuries. Then these columns must have been seen and imitated by the Greek; and the Greeks, therefore, are not the inventors of Doric architecture. But could the Greeks have seen these columns? There's the question in a nutshell. The writing on the subject is voluminous. Spare yourself the trouble of reading by accepting the sensible conclusion that it makes little difference whether a nation import or invent elements of art if it alone knows how to combine them into creations of life and beauty. One of these columns is no more suggestive of the Parthenon than a boulder of the glacial period is suggestive of the Pyramids.

Of the statues in the shrine very little is left. Another interesting question suggested is, how far was portraiture understood and permitted in Egypt. Very few Egyptian statues have strictly human countenances, but there are differences in noses, lips and

eyes, though none of the noses, lips and eyes may be exactly true. You learn to distinguish a statue of Ramses the Great from a statue of the Usertesan, or the Thothmes, family.

In some statues portraiture is undoubtedly attempted and approached, but there are so few instances of success that success seems an accident.

The tomb of Chnemhotep, which is immediately next to the tomb of Ameni, is quite as large and as interesting. Chnemhotep was as great a man under Usertesan II., as Ameni had been under Usertesan I. He was everything Ameni had been, even to being master of all the tunics. There are more hieroglyphic inscriptions in this tomb than in the other. In one of the inscriptions is this interesting statement: "My first honor was in establishing for myself a tomb chapel; for as the saying goes, a man should imitate the acts of his father. Now my father made for himself a ka-house in good stone, that he might plant his name in eternity; that he might make it firm forever, forever living in the mouths of generations, forever established in the mouths of the living." This seems to prove beyond all doubt that tombs were erected by the living, and not by their descendants, and that they were monuments of vanity and not of filial piety.

The chief interest of one picture in Chnemhotep's tomb arises from the fact that the persons represented are certainly not Egyptians. Egyptians did not have beards and did not wear variegated garments. Then who are they? That is another of the unanswered questions of Egyptology. The inscriptions about them state that they come from Abesha, that they are Aamus, and that they are bringing tribute of mesdemt. Mesdemt is supposed to be a precious paint which was used by the Egyptians for coloring their eyes. Where Abesha was, what the Aamus were, and what mesdemt actually is, await solution. Some pious parties are disposed to think that the Aamus were Jews, and that this sketch may represent Abraham's first visit to Egypt. Some of the noses are somewhat Jewish and the general aspect of the whole party is decidedly Semitic. The scene is, moreover, interesting as showing very early effort to depict a figure in profile. In the last figure to the left on the lower row, the artist still felt that he must show both shoulders; so he advances the left shoulder, which otherwise would be hidden by the right one. The same effort is seen in the figure in front of this one and in the second figure from the right in the upper row. The young ladies with their fine gowns and their diadems are still in the old style, that is, their feet and faces, with

the exception of the eye, are in profile, but their bodies are to the front.

The whole scene is discussed by Flinders Petrie in the first volume of his History of Egypt. The scene specially interests Petrie because it displays a civilization which is not Egyptian civilization, but is at least its equal.

Tomb No. 15 is one of the largest and one of the earliest, going back to the 11th dynasty. Baqt or Bakt, the occupant, was also one of the governors of the Oryx nome, and possessed of all possible dignities, honors and titles. On the north wall of the main chamber, the third row from the top, are women weavers, and then women acrobats, ball players, etc. Here are given two instants of the same jump, for the purpose of conveying a lively impression of jumping. There does not seem to be anything new in the world. Egypt must have had its Edison, and this, probably, was his first idea of the kinetograph.

Many of these figures are repeated so exactly on one of the walls of tomb 17 that the idea is again presented that the Egyptians were acquainted with some mechanical method of repeating figures by printing or by stencil plates.

One of the remaining columns in the main chamber of tomb 17 is another piece of evidence in the vexed question as to whether these caves did or did not suggest to the Egyptians their notions of building. Did the cave precede the temple and determine its architecture, or did the temple precede the cave? The argument is, that there is nothing in cave architecture to suggest this particular style of column, and as this particular style of column does exist in both religious and domestic architecture, these architectures must antedate the tombs. The answer to the argument is, that originally the support may have been a rough pier, such as are left in coal mines nowadays, and that the pier at a far later date was carved into the column.

The column itself is the well-known lotus column, of which the design is supposed to have been suggested by tying together four lotus buds just where they are connected to their long stems. That ornamental capitals were suggested by tying flowers about the tops of plain supporting posts is clearly shown from early Egyptian reliefs.

Attention should be called to the important monumental slab, discovered lately by Mr. Flinders Petrie amid the ruins of Thebes, which is still exciting the curiosity of the public and the controversy of learned Egyptologists. The slab is a magnificent cut piece of black

syenite; ten feet high, five feet wide and quite a foot thick, originally polished like glass. It was quarried, polished, inscribed and erected by Amenhotep III., of the XVIII. dynasty, about fifteen hundred years before Christ. The inscription was partially effaced by Amenhotep IV., who was a heretic, and wished to destroy all evidences of the orthodox religion. Seti I., the founder of the XIX. dynasty, and who was thoroughly orthodox, restored the inscription and re-erected the slab. Finally, Maremptah, the last king of the XIX. dynasty, who was rapacious and selfish, and who is supposed by some scholars to be the Pharaoh of the Exodus, made use of the slab for his own purposes. He built it into the walls of his palace, face in, and covered the back with a long inscription to his own honor and glory. In this inscription, for the first time in the history of modern Egyptian exploration, is found the word "Israel." It occurs in a sentence near the end of the inscription, which has been translated in several different ways.

The difficulties seem to be in the meaning of the signs which have been translated *Israel is without fruit*, and also in the signs translated *widow*.

At the meeting of the Oriental Congress, held in Paris last September, Naville, who is as near the top of Egyptology as any one, advanced the idea that the inscription was carved after the Exodus, when the Egyptians supposed that the Israelites had forever disappeared, swallowed up by the sands of the Arabian desert.

That so far no other allusion to Israel has been found in Egypt is a disappointment to Bible scholars. But they should consider that the thorough exploration of Egypt has only commenced, and that any day a discovery may be made which will bring full satisfaction to the strictest orthodoxy.

THE PHYSICAL GEOGRAPHY OF NEW YORK STATE.

RALPH S. TARR.

PART III.—PLAINS AND PLATEAUX.

CONTENTS.

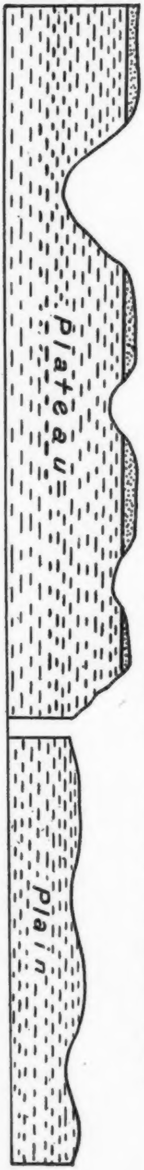


FIG. 1.—DIAGRAM TO SHOW THE TYPE CONDITIONS OF PLAIN AND PLATEAU. BASAL LINE SEA LEVEL. CRESTS OF HILLS IN PLATEAU CAPPED BY HARD STRATUM.

DEFINITION.—A plain is a level tract of country, and it is customary to limit the term to level tracts not high above the sea, while those that are elevated are called plateaux. Naturally this distinction has little if any meaning, even in common usage, for there are many so-called plateaux, such as that on the western side of the Appalachians, which are less elevated than the "plains" of the West. Therefore I do not consider it worth while to attempt to maintain the distinction in this article. Plains and plateaux are of the same genus, the difference arising chiefly out of the difference in elevation and the results which this makes possible.

LIFE HISTORY.*—Both plains and plateaux, in their typical development, are notably level areas; but a plain that for any reason begins as a level tract, will, if opportunity offers, become irregular. Upon its surface water will flow; and this, if high enough above sea level, will of necessity cut channels. Hence the plain will begin to be dissected, and if a plateau high above sea level, it may be so deeply carved that, like the Catskills,† it becomes so mountainous that people class it among mountains. Therefore in the development of a plain

* Davis, Proc. Am. Assoc. Adv. Sci., 1884, XXXIII., 428–32.
† Tarr, Bull. Am. Geog. Soc., 1897, XXIX., 36.

from an original fairly level condition, greater and greater irregularity is introduced, until the plain becomes a hilly, or, so far as differences in level go, even a mountainous country.

At first * the streams cut steep-sided valleys, to shallow depths if the plain is low, but as great cañons if on a high plateau. This is because the streams cut rapidly along their channels and carve valleys only slightly wider than themselves. But the weather is at work all the time, and this broadens the valleys, making them less angular. Yet as long as the stream can cut into its bed, *its* action is more marked than that of weathering, and although the valley broadens, it still remains a gorge or cañon. In time, however, the stream cuts so low that further deepening is either greatly checked or wholly stopped. Then the sole action of weathering broadens the valley, and this carving of the plain, in the end, produces broadly sloping valleys and gently rounded hills. This stage is reached much more quickly in a moist than in a dry climate, because the agents of weathering are less active in the latter than in the former. This is one of the reasons why the plateaux of the arid West are crossed by rugged and narrow cañons, while that near the base of the Appalachians is carved into rounded hills and valleys.

Beyond this stage the development is slow; but since the streams can cut no deeper, while weathering is constantly reducing the surface, there is no other end than the ultimate reduction of the surface to a level condition, provided the land stands quietly and nothing occurs

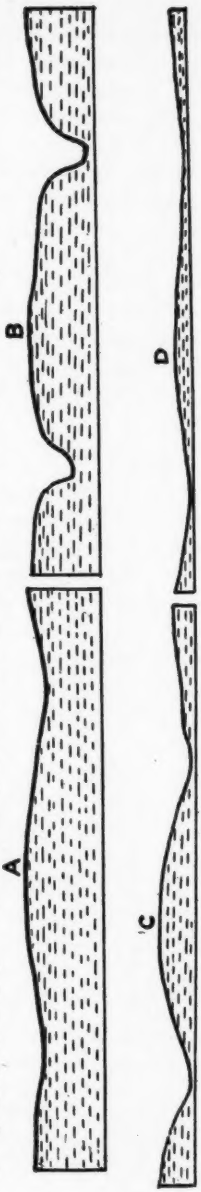


FIG. 2.—TO ILLUSTRATE IDEAL DEVELOPMENT OF PLAIN IN ROCKS OF UNIFORM TEXTURE, STARTING WITH UNDULATING SURFACE IN A; TRENCHED BY STEEP SIDED VALLEYS IN B; THESE BROADENED OUT IN C TO THE CONDITION OF MATURITY; AND FINALLY, IN D, A GENTLY UNDULATING PLAIN DEVELOPED THROUGH DENUDATION, BUT THIS TIME NEAR SEA-LEVEL.

* Davis, Proc. Am. Assoc. Adv. Sci., 1884, XXXIII., 428–32.

excepting this normal work of water and weather. The plain, at first roughened by these causes, then, after a certain stage is reached, becomes more and more smooth, until in the end it would actually become a plain again, as at the start, though this time with the surface near the sea. It happens that the land *is* in movement, and that other things may occur to interrupt this development, so that the full cycle is rarely, if ever, completed. Of *young plains* (A and B—Fig. 2), that is, those newly formed, there are many; of *mature plains* (C—Fig. 2), that is, those considerably dissected, there are also great numbers; but of *old plains* (D—Fig. 2), those that have passed into a second childhood, we have none of any size that can be proved to be of this origin. The RATE of development from youth to old age, as well as the intensity and variety of surface form produced, will vary greatly with the elevation above the sea, the kind of rock, whether hard or soft, the slope of the surface, etc.

CLASSIFICATION OF PLAINS.*—There are two great classes of plains, those that have resulted from *destruction* of land and those that have been built up, or *constructed.* The former may be called *destructional*, the latter *constructional.* Both classes may be made by several causes, such as the action of the sea, of lakes, of rivers and of glaciers. Plains produced by these causes may be called Marine, Lacustrine, Fluviatile, and Glacial. When a glacier is ending on the land, its melting furnishes both water and sediment in amounts quite different from that which would come under more normal conditions. The action of this ice-furnished water may also build plains, as well as carve them, and these may be called Glacio-fluviatile plains. Volcanic action, by outpouring lava or volcanic ash, may build Volcanic plains. During the general wearing down of the surface, by the action of *denudation*, plains may be formed by the important agents of destruction included in this term. Plains originating from EITHER one of these causes may be newly formed, and hence young, or they may become mature, or, theoretically, any one may have passed to the stage of old age. These facts are graphically stated in the following table, to which are added the names of some of the chief subdivisions of these several classes:

*See also Davis, Proc. Am. Assoc. Adv. Sci., XXXIII., 1884, 428-32; Powell, Nat. Geog. Monog., Vol. I., 1896, 34.

CLASSIFICATION OF PLAINS.

	CONSTRUCTIONAL.	DESTRUCTIONAL.	
Marine.	Salt marshes. Deltas. Filled bays. Raised sea-bottoms.	Wave cut plains.	Any of these may be young, mature or old.
Lacustrine.	Fresh water marshes. Deltas. Filled lakes. Lake bottom plains.	Wave cut plains.	
Fluviatile.	Floodplains. Terraces.	River cut plains. Terraces.	
Glacial.	Till plains.	Ice-scoured plains.	
Glacio-Fluviatile.	Gravel-filled valleys. Overwash plains. Terraces. Deltas. Sandplains.	Same as Fluviatile.	
Volcanic.	Lava flows. Ash fields.	None.	
Plains of Denudation.	All of the above excepting volcanic.	Plains in horizontal rocks. Peneplains.	

Constructional Plains.

Marine Plains.—Along a very large part of the sea-coast line of New York, *salt marshes* are in process of construction, and one finds every gradation, from a bay to an extensive marsh. This coast line, which is mostly that of Long Island, is very irregular, and the indentations have chiefly resulted from a recent sinking of the land, which has allowed the water to enter the valleys. Hence the Hudson, and many of the streams of Long Island, enter the sea, not over deltas, but at the head of bays and fjords. These partly protected indentations do not receive the full force of the ocean waves, and hence the sediment that is dragged down from the land by rain-wash and by rivers, is not removed by sea action, but accumulates on the bed of the bays, tending to fill them. An even more important reason for this protected condition over a large part of the coast, particularly along the shores of Long Island, is the construction of bars of sand by wave and wind action. Hence the greater portion of the south shore of this island is largely shut in by sand bars, or beaches, at some distance from the true land margin, or the *old land.* The *new coast* is therefore straighter than the old, and the space between the old and new land is occupied by protected bays

and sounds. From here southwards to the Rio Grande, excepting at the southern end of the Florida peninsula and the delta of the Mississippi, these same conditions exist.

Delta Plains.—Where streams enter these bays they deposit their sediment very nearly at the place where the current is checked upon entering the quiet water. The continual dumping of

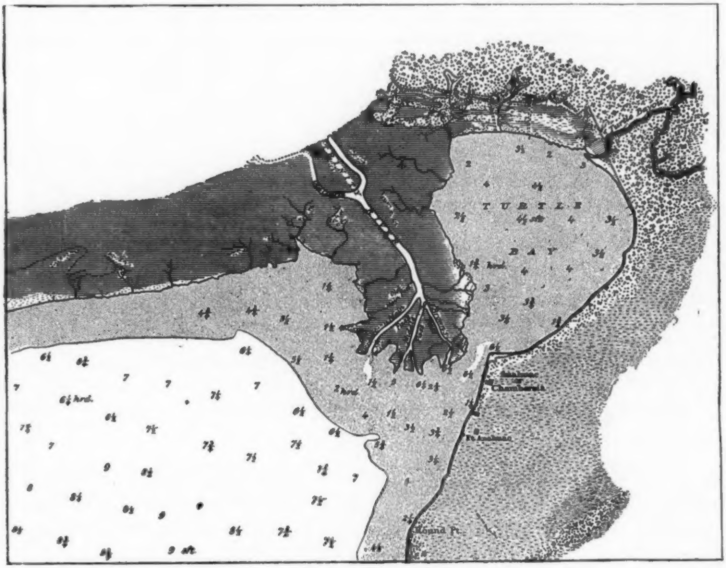


FIG. 3.—MAP OF A DELTA AT THE HEAD OF GALVESTON BAY, TEXAS, WHERE THE TRINITY RIVER ENTERS. NOTE THE SHALLOWNESS OF THE WATER NEAR THE DELTA AND IN TURTLE BAY (FROM U. S. COAST SURVEY CHART 204).

material here will, in time, build *marine delta plains.* Layer upon layer is deposited, and the delta grows outward into the bay, with a level upper surface and a steep front under the water, upon the face of which sheets of sediment accumulate at a steep angle (Fig. 4). Thus, built as a plain, which is a part of the sea shore, it cannot grow far above sea-level. Hence, this action makes it a nearly dead-level plain, and when the stream that is building it, and that extends out over it, is in flood, the nearly horizontal channel cannot contain ALL the water that is supplied. Therefore the water overflows the delta and deposits upon its surface a horizontal layer of sediment, so that the plain is actually built a slight distance above sea-level, as is the case in the delta of the Mississippi. Being gen-

erally enclosed between hill slopes, sediment is washed from the sides; and hence, under such conditions, the delta is a plain sloping from the valley-sides toward the middle, and from its head to its

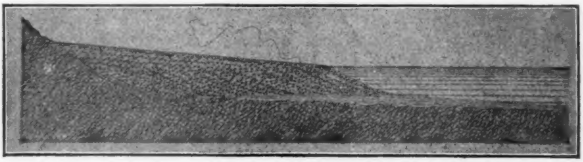


FIG. 4.—IDEAL SECTION OF A DELTA, AFTER GILBERT. SEA-LEVEL THE HORIZONTAL LINE ON RIGHT.

margin, which is really some distance under water, where it terminates in a terrace front that is constantly being extended seaward.

Such a delta plain is very level, but yet is marked by some depressions and elevations. Places, especially those near the stream channel, where more deposit is made, rise above this level, and the river may enter the sea through two or more mouths, or *distributaries* (Fig. 3). Now and then it abandons one of these, or changes its course, thus leaving the old channel and carving a new one. Then the abandoned channel becomes a *bayou*, and later, cut off from the sea and river by the deposit of sediment, may become a lake. But these are all minor irregularities in a plain of remarkably uniform general level.

Filled Bays.—The sediment brought by the rain and the small streams, as well as that coming from the large rivers, together with some of wave origin, drifted about by tidal currents, is strewn over the bed of the bay. This is deposited quite irregularly, according to the rate of supply and the velocity of the current, which varies from place to place. If this filling continues long enough, the effect would be to transform the bay to a level plain (a *filled bay*), whose elevation was approximately that of the sea-level, at which level further deposit would be greatly checked and finally stopped.

Salt Marsh Plains.—This work of bay-filling is greatly aided by the action of marine plants.* When any portion has risen nearly to the low-tide mark, eel grass commences to grow, and this, by checking the velocity of the tidal current, adds to the shallowness, which is still further increased by the death of the eel grass itself, as well as by that of the animals which it supports. This continues about to the low-tide level, where the eel grass ceases to be able to thrive. Above this there is a barren zone up to the level of the midtide,

* Shaler, Sixth Ann. Rept. U. S. Geol. Survey, 1885, pp. 353–398.

where other plants, the salt marsh grasses, commence to thrive, with the same result. They can grow upon a salt swamp up to the level of the highest tide, and as a result, by their aid, extensive

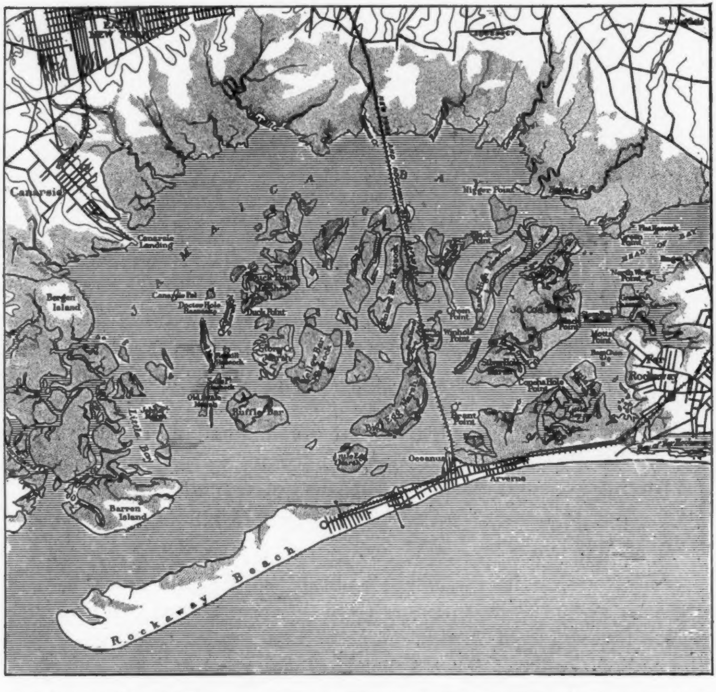


FIG. 5.—A NEARLY FILLED BAY JUST SOUTH OF BROOKLYN ALMOST ENCLOSED BEHIND A BAR CALLED ROCKAWAY BEACH. VERY NOTABLE DEVELOPMENT OF SALT MARSH, REPRESENTED BY THE DOTTED SHADING (FROM BROOKLYN SHEET, U. S. GEOL. SURVEY).

plains are being built in the enclosed bays; and in some places these stretch as salt marshes from the ocean beach or bar to the margin of the old land (Fig. 6). They are remarkably level marine swamps, with minor irregularities, which are covered at very high tide, but exposed to the air for most of the time. Through them extend many river-like, tidal channels, through which the rising and falling tide passes. In time even these are filled, and gradually the plain is raised above the level of the highest water, and the salt marsh then becomes dry land.

These salt marsh plains have considerable economic importance. There are scores of thousands of acres along the sea coast, not far

from the large cities, which need only the exclusion of the tide to transform them to arable land. Already this has in some cases been done by artificial diking, and in the Evangeline County of

FIG. 6.—SALT MARSH PLAIN AT IPSWICH, MASS. WOODED GLACIAL HILLS RISE ABOVE THE PLAIN, AND THE OCEAN SAND BAR, BEHIND WHICH IT HAS BEEN FORMED, IS SEEN IN THE WHITE HILLS IN THE BACKGROUND (PHOTOGRAPH BY J. L. GARDNER, 2d).

Nova Scotia, near Cape Blomidon on the Bay of Fundy, on the coast of England, and particularly in Holland,* very extensive salt marsh plains have been reclaimed from the sea. In time, however, nature herself will reclaim them.

Not far from the City of Brooklyn, and along the coast of New Jersey, just south of New York City, there are extensive salt marshes,† and all along the Long Island shore, as well as that of Connecticut to the north of this, there are patches of this marshy land.‡ Sometimes these grade almost imperceptibly into dry land; and habitable plains end, without any sharp line of demarkation, in a salt marsh. Being nearly at sea-level, the marine plains so far described, unless elevated, can pass through no complex stages of development, but will remain level tracts of land near sea-level, and crossed by streams flowing in almost imperceptible valleys.

---

* Smock, Ann. Rept. New Jersey Geol. Survey, 1892; 313–353.

† Vermeule, Ann. Rept. New Jersey Geol. Survey, 1896; 287–317.

Cook, Geol. Survey, New Jersey. Report on Cape May County, 1857, pp. 15–65, 91–94; Ann. Rept., 1869, pp. 23–41; Geology of New Jersey, 1868, pp. 300–308; Annual Report, 1885, pp. 61–70.

‡ Mather, Geol. of New York, First Dist., 1843, pp. 17–19; p. 234.

Raised Sea Bottoms.—Further to sea, beyond the new land, the tidal currents and waves are distributing sediment over the bottom, building a plain on the ocean bed. For a distance of 75 or 100 miles from the New York and New England coasts there is such a plain of remarkable levelness, made of layers of sediment which have obscured many of the irregularities that may have once existed. If the land along this part of the continent should rise to an elevation 600 feet above the present, there would be a coastal plain sloping gradually from the present shore line to the new sea shore. Such an elevated *sea bottom plain* would be a constructional plain built by deposit and raised into the air by the forces of elevation.

This case finds no actual present illustration within this State; but just south of it, in New Jersey, and from there to the Rio Grande, the lowlands bordering the coast are actually of this origin. The plain of the Pine Lands of New Jersey (Fig. 7) and the coastal plains* of the Southern and Gulf States, represent an old sea bottom slightly elevated above the ocean. That of Texas has been so recently elevated that fossils of animals now living in the Gulf are enclosed in the clays; and it is so young, and the slope so moderate, that it is a great, swampy tract, with streams flowing almost without valleys.

FIG. 7.—IN THE PINE-LANDS OF NEW JERSEY. RAISED SEA-BOTTOM PLAIN (DAVIS SERIES OF GEOGRAPHICAL LANTERN SLIDES).

While at present New York has no such plains as these, we are able to look back in time to a period when there were such level tracts stretching westward from the old land which existed among the ancient Adirondacks and New England mountains (see Part II of this series). Near the close of the Paleozoic, when the Appalachians were uplifted, these *coastal plains* were elevated above the great interior sea, and they were very extensive, including the greater part of New York. It was upon this plain that the vegetation grew out of which the coal beds of Pennsylvania have been

* McGee, Twelfth Ann. Rept., U. S. Geol. Survey, 1891, pp. 347–521.

made; and it is not improbable that similar tree-covered swamps at the same time existed in New York, although now all traces have been removed by denudation. The history of this ancient plain, since that time of first uplift, has been so complex, and the record of it so battered by the attacks of the agents of destruction, that it is only by a careful study of the geology of the region that we are able to state these facts. The low plains have been raised to plateaux and greatly dissected and transformed (Fig. 17); but in the beginning they were true sea-bottom plains.

LACUSTRINE PLAINS.—*Lake-Bottom Plains.*—In lakes very nearly the same kinds of plains are made as those of the sea, and this State furnishes many illustrations of the several kinds. During the closing stages of the glacial period there was an ice dam across many of the streams; and temporary lakes existed where now there is dry land.* Most of these were small, and the deposits in them have built either small plains, or else have not been extensive enough to smooth over the lake bed. Such plains may be looked for in many of the valleys of the north-flowing streams, most of which were held back by the ice dam. However, in the case of the Great Lakes,† while the outlet through the St. Lawrence was clogged by ice, the level of the waters was raised so that at one time the outflow was past Chicago, and at another past Fort Wayne, Ind., and still later through the Mohawk in New York. The last stage existed for a long time and extensive beaches were built. Beaches made during these high-water levels were constructed along the shores of both Erie and Ontario. These extend as ridges or narrow plains, which are really terraces, remarkably level and continuous.

During this stand of the water, deltas were constructed which now exist as broad, level-topped areas of gravel. Over the bed of the lake, sand and clay were strewn, filling some of the depressions, so that the surface, already quite level, was made into a more typical plain. Therefore, south of the beach-terraces and ridges now forming on the present lake shore, there are plains which were once lake bottom, and which owe some of their levelness to this fact.

---

* For the Red River plains of Dakota and Canada, see Thomas, Hayden Geol. Survey, Sixth Report, 1872, p. 293; Upham, Monograph, U. S. Geol. Survey, Vol. XXV., 1895. For Bonneville Plain, see Gilbert, Monog., U. S. Geol. Survey, Vol. I., 1890. This lake bottom plain is not of glacial origin.

† The history of the Great Lakes will form a separate part of this series, and then these deposits will be more fully described with bibliographic references.

If Lake Erie should be drained there would be a similar, though much more extensive, plain on the site of the lake.

*Lake Delta Plains.**—In lakes, especially the smaller ones, the water is shallow, the bottom is not sinking, and there is only slight wave action, and no marked tides. Hence in these there is less chance of removal of sediment than in the sea. Rivers bringing their load to the ocean do not succeed in accumulating all of it near their mouths, but much of it is strewn over the sea floor, being carried hither and thither; those entering lakes lose nearly all of their load, and most of it is dropped near their point of entrance. The lake filters the water of its sediment, so that the outflowing stream is pure and clear. Some of this sediment is strewn over the lake bed; but most, and the heaviest, settles near the river mouth, building a delta. Therefore opposite the mouths of most streams entering lakes there are true delta plains, some of which are quite extensive.

In the Finger Lakes these are abundant, and at the head of each of these there is a broad flat which is a true delta. These are not truly level, but extend beneath the lake water at their margin, are swampy near the shore, and rise gradually both from the lake shore and from the central part of the valley toward the margin. This elevation of the surface is due to the deposit of sediment brought by the normal river floods. The town of Ithaca, at the head of Lake Cayuga, is built on such a delta, and mainly on the eastern side of it. The town of Watkins, at the head of Lake Seneca, is on the western side of a similar delta. The position of these towns is due to the fact that the tributary streams from the east are more numerous in the former case, and from the west in the latter. They have elevated the surface of the delta near their mouths, and transformed it to dry land, while the opposite side is swampy. These are true, though very flat, alluvial fans.

Lake Swamp Plains.—As in the case of the sea, so in lakes, when the bed has been raised enough, vegetation commences to take root. On the exposed shores of large lakes this is not possible, because the waves keep the mud and sand in such movement that the plants cannot take root; but here, as in the sea, there are bays, and there are also places protected by sand bars, and in these vegetation can grow, as it can also in the smaller lakes in which large waves cannot be generated. The life and death of plants helps to build up the bed, partly by their own addition, partly by the accu-

* Gilbert, Monograph, U. S. Geol. Survey, Vol. I., 1890, pp. 65–70; 153–167.

mulation of remains of animals which thrive in the plant-covered plains, and partly by entangling sediment, and causing it to settle in the quiet water. These often transform the shores of lakes, especially small ones, to swampy plains.

Filled Lake Plains.—In the end the work above described may completely *replace* the lake by swamp. A very large majority of the peat-bog swamps of New York, such as those which abound in

FIG. 8.—STREAM (RAY BROOK) IN THE ADIRONDACKS MEANDERING THROUGH A FILLED LAKE PLAIN (PHOTOGRAPH BY S. R. STODDARD, GLEN'S FALLS, N. Y.).

the Adirondacks,* are the result of this transformation of lake to swampy plain by the filling of the lake, at first by the deposit of sediment, and later by the aid of plants. Many of these bogs have been cut into for one purpose or another, and in them one commonly finds, after passing through several feet of peat, perhaps with thin layers of marl, a bed of clay which represents the first step in filling the old lake or pond. There are thousands of acres of such plains in New York, and some of them are of large size. In Nova Scotia one may frequently see such plains with a diameter of two or three miles.

FLUVIATILE PLAINS.—If, for any reason, a stream flows over a level area with such moderate slope that in time of flood all the water cannot be carried in the channel, when it overflows its banks it spreads out as a sheet of water on either side of the channel. In this lake-like expanse the current is so reduced that some of the sediment is deposited as a sheet, by means of which the irregularities are smoothed over, and a plain formed. This flood-plain is

* Smyth, Am. Geol., 1893, XI., 85–90.

gradually *built* up, and in time may become very extensive, as in the case of some of the great rivers of the world, like the Mississippi.

New York has no such great FLOODPLAINS, though many streams are bordered in part of their course by small ones. This is true, for instance, of streams flowing over deltas, or where they pass across swampy plains that have been built up by lake filling. They also exist where the river course is interrupted by deposits of glacial drift. In parts of the Hudson there are extensive, though narrow floodplains; and in the Susquehanna, Mohawk and Alleghany valleys there are level areas which are true floodplains, and over which the river rises when in high water; but though these are at times of considerable area, they are nowhere of great extent.

These bordering plains may become true *terraces*,—that is, narrow plains bordered toward the river by a steeply descending bank; and often, on the side away from it, by a steeply ascending slope. These are generally due to the cutting action of the river (p. 49), but such terraces are occasionally *built up* by river floods of variable height.* Since none are known in New York it will be sufficient merely to mention this class.

GLACIAL PLAINS.—By these are meant plains constructed by the direct action of the ice itself. When the continental glacier extended across New York, covering the entire area of the State, which was, therefore, transformed into a plain or plateau by the ice covering, all irregularities were submerged and there was a great *ice plateau*, like that now covering Greenland. While this ice existed, moving slowly southwards, it ground the surface somewhat, picked up a load of rock fragments, and dragged these southwards. When these reached the end of the ice, part went away in the streams furnished at the glacier's end by the melting ice, and part accumulated along the margin, forming terminal moraines. There was a constant procession of rock fragments toward this margin, and at any one time the ice held considerable in its grasp, firmly frozen in the bottom layers of the glacier, as we find at present in Greenland. When the ice melted, this *débris*, *till* or *boulder clay* it is called (Fig. 9), was left at the place where it happened to be, so that much of the surface of New York is now covered with a coating of boulder clay, in which clay is the chief element, but scattered through which are numerous boulders of rock not found in any of the neighboring ledges, but dragged from the north; and upon their surface are often seen scratches which they have received on the

* See Tarr, Am. Journ. Sci., XLIV., 1892, 59–61.

journey. This till layer varies in thickness, sometimes barely covering the rock, or even being entirely absent, sometimes reaching a thickness of several hundred feet. In the Western States the

FIG. 9.—SECTION IN TILL OR BOULDER CLAY IN PENNSYLVANIA (LEWIS, REPT. Z, PENN. GEOL. SURVEY).

general till covering is very deep, so thick, in fact, that the preglacial topography has been almost obscured beneath a great thickness of drift. Borings for oil and gas in Ohio and Indiana have revealed buried river valleys beneath the thick till covering of the prairies. Therefore, this part of the extensive plains of the Central States owes its levelness, in large part, to the glacial deposits, and is, therefore, a true till plain.

Most of New York is too hilly for this, but the glacier has greatly reduced the original irregularities, partly by cutting down the hilltops, and partly by carrying off the materials thus derived and depositing them in the valleys. There are hundreds of cases in which stream valleys have been so filled, that, after the ice left, the rivers were not able to occupy them. Some of these are still to be seen as sags in the surface, but others are entirely obscured, though the great majority have merely had their depth decreased by the deposit of drift. By this means the valley bottoms, originally one or two hundred feet deeper than at present, have been filled with till and transformed to valley-bottom plains.

In addition to this, there are narrow, terrace-like till plains, clinging to the hillsides above the valley bottom, apparently representing deposits held *under*, or in the bottom of the ice, when the valleys were filled by the glacier, and allowed to drop down into their present position when the ice support was removed. In the

hilly plateau region, near the divide of the Finger Lakes and Susquehanna, there are many terraces of this origin.

Besides these small plains, there is one extensive level area which owes at least a part of its levelness to this cause of ice filling. This is the plain which borders the Lake Ontario shore (p. 52), and which, except where roughened by irregular glacial deposits, is, in general, remarkably level. The surface of this must have been *somewhat* level before the ice came; but presumably it was crossed by river valleys. Indeed, some of these still show, as in the case of Irondiquoit Bay, which is apparently the pre-glacial course of the Genesee River. Practically all, however, have been obscured by the glacial deposits; and so this, which was apparently a dissected preglacial plain, is now a very regular till-covered plain.

GLACIO-FLUVIATILE PLAINS.—While the ice front stood at its farthest limit it reached into Pennsylvania, then covering nearly the entire area of New York; but as the glacial period waned, the ice melted, and its front gradually stood along lines farther and farther north. Wherever it remained its melting furnished the streams with great volumes of water and of sediment, thus introducing conditions quite different from those of the present and the earlier past. It may be said that this water and sediment, escaping from the ice front, passed either into streams leading *away from* the ice, or into streams flowing northward which led *toward* the ice front. In the former the water found ready escape; but in the latter it was ponded by the ice dam. In both cases the great volume of sediment-laden water built deposits of interest, some of which are true plains, though usually not of large size.

*Gravel-Filled Valley Plains.**—Where the water found a slope down toward the south, either this was sufficient to allow the great floods to carry all of the sediment, or else it was too slight for this; and in the latter case some of the load had to be deposited. Because so much sediment was supplied, the latter was frequently the case. Even at present, at the margins of the Alpine glaciers, the streams are not able to carry all their sediment load down the steep mountain valleys; and a similar condition is found along the margin of many other glaciers, notably the Malaspina of Alaska (Fig. 10). Hence the streams, depositing some of their sediment, gradually built up their beds, perhaps flowing over the plain in numerous *anastomosing* channels. By this means many valleys of streams flowing southwards from the glacier have had a deep filling of sand and

* Salisbury, Ann. Rept. New Jersey Geol. Survey, 1892, pp. 96–125.

gravel.* One may see this class of plain in many of the tributaries of the Susquehanna and Allegany. They are so numerous that

FIG. 10.—DELTA PLAIN BEING FORMED AT MARGIN OF MALASPINA GLACIER BY DEPOSIT OF GRAVELS BROUGHT BY THE WATER FROM THE GLACIER, BUT NOT CAPABLE OF BEING CARRIED FARTHER (PHOTOGRAPH BY PROF. I. C. RUSSELL).

some form of development of them may be looked for in nearly all of the south flowing streams of New York.

The influence of this kind of deposit is felt even as far as the sea. The floodplain and delta of the Mississippi contain a vast amount of sediment furnished by the melting glacier, and some of the loess of the Mississippi Valley, by which certain prairie areas have been made, had a similar origin. The building of these gravel-filled valley plains, and the prairie areas of fine grained clay, was aided by the fact that when the ice was melting away from the country, the land was lower in the north than now; and hence the south-flowing streams had their grade decreased.

Overwash Plains.—Where the surface was moderately regular, but gradually sloping toward the south, many small streams escaping from the ice front combined to build coalescing plains, or flat, alluvial fan deposits, to which the names *overwash plains* or *frontal aprons* have been given. Within the boundary of New York these are typically illustrated on the south side of Long Island,† where there are extensive sandy plains bordering the southern margin of

* Brigham, Bull. Geol. Soc. Am., VIII, 1897, 17–30.

† Lewis, Am. Journ. Sci., XIII, 1877, 235; Upham, Am. Journ. Sci., XVIII, 1879, 81–92, 197–209; Hollick, Trans., New York Acad. Sci., 1894, XIII, 123–130.

the terminal moraine. In the more hilly region of central and western New York there was little chance for these to be formed. Their place is taken by gravel-filled valley plains, though here and there these are broad enough to be classed as frontal aprons. An illustration of this is found just southwest of Cortland, N. Y., and another at Elmira and Horseheads.

*Terrace Plains.**—In many of the stream valleys flowing southwards there are well developed terraces, which are true plains, narrow to be sure, and extending parallel to the streams, sloping southward with them. Nowhere are they better developed than in the Connecticut River valley, where, in some places, there is a series of several well developed terraces, composed of clay, sand and gravel, with level top and steep margin. In origin they are associated with the withdrawal of the ice sheet; but there are two possible explanations, one of which only (constructional) is mentioned at this point. (For the other see p. 49.) This explanation is that the sediment-laden river water was subjected to risings and shrinkings with the change of season. In winter the river was small and occupied a narrow channel. In spring it rose to a higher level and had a broader channel, the present first terrace top; in summer, rising still higher, it filled a still broader and deeper channel, etc. By this explanation each level of the floods occupied a channel of different breadth and depth; and, since *deposits* were being made all of the time, terraces were built, just as a *single* terrace is being made by rivers which occupy a narrow channel at ordinary stages, and a broader one during flood times, when they overflow their floodplains. The floodplain is a true terrace of construction, and accordingly, if this explanation is true, such terraces as those of the Connecticut are merely the floodplains made by floods which rose to different levels in different seasons.

Deltas.—Where the glacial streams entered valleys whose natural slope was toward the north, they were transformed into lakes in which their sediment was deposited, as it is in any lake; and since many of these have now entirely disappeared, the deposits that were then made, now appear as part of the land surface. Some of these have made plains like those existing around the shores of the Great Lakes (p. 37). Generally the *beach terraces* are indistinct, though they are very prominent along the ancient shores of Ontario and Erie, and less so about some of the smaller, entirely extinct lakes. Therefore, in many places, as, for instance, along the margin of the

* Tarr, Am. Journ. Sci., XLIV, 1892, pp. 59–61.

Finger Lakes * and Lake Chautauqua, there are gravel terraces, quite level-topped, which border the tributary streams at various elevations above the present lake surface. These streams, flowing down the

FIG. 11.—SMALL DELTA BEING MADE IN A LAKE AT THE MARGIN OF THE GREENLAND ICE SHEET AND SUPPLIED WITH WATER FROM THIS GLACIER.

hillside, entered the lakes during their higher stages, deposited their sediment and built deltas (Fig. 11), as streams are now doing where they enter these lakes at lower levels. They, therefore, stand as witnesses of the former higher water levels.

Sand Plains. †—Even more extensive plains of gravel exist here and there in these valleys in positions where it is difficult to account for the source of the gravel. These *sand plains* have the form of true deltas with level tops, furrowed with numerous channels and terminating in a steep front, facing southwards. They were evidently built by the deposits made from a gravel-laden stream, now

* Hall, Geology of New York, 4th Dist., 1843, pp. 342–7; Lincoln, Am. Journ. Sci. XLIV, 1892, 297; New York State Museum Report, Vol. 48, 1895, p. 74; Fairchild, Bull. Geol. Soc. Am., VII, 1896, 423–452.

† Davis, Bull. Geol. Soc. Am., Vol. I, 1890, p. 195; Gulliver, Journ. Geol., Vol. I., 1893, p. 803; Upham, Bull. Geol. Soc. Am., Vol. VIII, 1897, p. 183.

extinct; and careful studies have shown that these streams came from the ice which was forming the dam for lakes now gone, as are the streams themselves. Such plains have not been described from New York, but one is found north of Geneva and another, possibly of this origin, near the town of Brookton, just southeast of Ithaca.

OTHER PLAINS.—During the stay of the ice upon the land, the elevation with reference to the sea-level was lower than now, and the sea entered the Hudson River at a higher level than at present. Then the streams tributary to this river entered a fjord; and being

FIG. 12.—THE MONTEZUMA MARSHES, NORTHERN END OF CAYUGA LAKE (PHOTOGRAPH BY C. S. DOWNES).

loaded with sediment,* they built deltas and terrace deposits in the Hudson itself and its tributaries. Many of these furnish illustrations of these plains, as may be seen near the mouth of the Mohawk and Catskill.†

* Streams then carried more sediment than now, both because the ice was furnishing them with it, and because the land from which the ice had recently disappeared had not yet been protected by vegetation, so that the rain fell upon it with something like the effect that is produced when it falls upon a road, or a ploughed field, in contrast to a pasture or a forest.

† Hale, Am. Journ. Sci., 1821, III, 72–3; Finch, same, 1826, X, 227–229; Mather, Geol. of New York, 1st District, 1843, pp. 129–158; Dwight, Trans. Vassar Bros. Inst., III, 1884–5, 86–97; Davis, Proc. Bost. Soc. Nat. Hist., XXV, 1892, pp. 318–335; Ries, Trans. N. Y. Acad. Sci., 1891, XI, 33; Merrill, Am. Journ. Sci. 1891, XLI, 460–66; Taylor, Am. Geol., 1892, IX, pp. 344.

In the temporary lakes not only was sediment deposited in abundance opposite stream mouths, but some was carried out into the lake and strewn over the floor,* which in some cases was transformed to a plain of gravel, sand or clay (p. 37). Some of these plains are now to be seen in the north-sloping valleys, in which they resemble the gravel-filled valleys of south-flowing streams. In other cases, as in the Montezuma marshes (Fig. 12) at the head of Lake Cayuga, and the Conewango Swamps southeast of Jamestown, in Chautauqua County, there are extensive lake-bottom plains, still in a swampy condition.

Volcanic Plains.—Since New York is not a volcanic region, there are no illustrations of these plains within its boundaries, and therefore this subject may be quickly passed over. A lava flow, spreading out over a moderate slope, fills irregularities and may build a plain; and so also may volcanic ash erupted and strewn over the country on one side of the cone. Lava plains have certainly existed in the Connecticut Valley, and possibly also in New Jersey; but subsequent changes have entirely destroyed the plains, for the lavas now stand tilted into mountainous elevations.† In the far West many of the plateaux are capped by lava flows of this origin.

Destructional Plains.

Wave-Cut Plains.‡—The agents of denudation are planing down the surface of the land and carrying materials toward the sea, where extensive plains are being constructed (p. 31); and on their way, stopping in lake or river valley, plains of small extent may be *built;* but in the course of this work of degradation, plains may also be formed by the very *work of destruction*, without the action of building. For instance, the waves, either of lake or sea, may saw into the land, forming wave-cut plains which are generally of small extent and lie beneath the water. Later, these may, perhaps, be raised above the surface.

This horizontal planing of the land by ocean waves is believed by many to have produced grand results in the past, and this has been especially urged by the British geologists. Standing upon the tops of the hills in the Highlands of Scotland and England it is found that they rise to nearly the same level, and it has been suggested that these hilltops are remnants of an ancient *plain of marine denudation*, formed at a time when these islands were at a

---

* Ries, Trans. N. Y. Acad. Sci., 1893, XII, 107–109.

† See second article of this series, Bull. Am. Geog. Soc., XXIX., 1897, 34.

‡ Gilbert Monograph, U. S. Geol. Survey, Vol. 1, 1890, pp. 35–36.

lower level, during which the waves beat against them for such a long time that the lands were bevelled. Elevation has since raised these plains and streams have cut into them, so that only remnants now remain in the form of hilltops reaching to a nearly uniform level. Since the rocks of the region are of different degrees of hardness, the explanation of the uniform hilltop level must be some condition of lower level than the present; and one possible explanation is this which has been stated. American geologists are inclined to call these remnants *peneplains*, which have resulted from denudation in the air (p. 55).

RIVER-CUT PLAINS.—As they are cutting their valleys, rivers are caused to meander, and the curve of meander changes gradually, so that in the course of time the river shifts its bed, having its

FIG. 13.—TO ILLUSTRATE TERRACE FORMATION BY LATERAL CUTTING OF A RIVER, WHICH IS ALSO CUTTING INTO ITS BED. THERE IS HERE ONE TERRACE; BUT IF THE STREAM CHANGES ITS POSITION TO THE LEFT, AND THEN CUTS DOWN ALONG ITS BED, A LOWER TERRACE WILL EXIST WHERE THE RIVER BED IS NOW LOCATED (PHOTOGRAPH BY JACKSON, DENVER).

channel now on one side of the valley and now on the other. As it swings it cuts a plain whose width is equal to the change in position. This is known as *planation.**

It is by this action that it is believed that the terraces of destruc-

* Gilbert, Geology of the Henry Mts., Washington, 1880, p. 120.

tive origin are formed. According to this theory, as applied, for instance, to such a river as the Connecticut (p. 44), floods of glacial waters, instead of *building* terraces, gradually *deposit* the sediment in a sheet over the river bottom, building up an extensive gravel plain like those described above (pp. 42–43). After the sediment supply ceased, the stream began to cut a valley in this, for it was no longer *overburdened* with sediment, and its slope was increased by the uplift of the land in the north. Cutting a channel in one place, and then gradually swinging laterally to another point, where it remained to cut another channel, and then changed again, etc., the gravel plain was carved into a series of terraces as the river excavated its channel in the gravel.* Both the constructional and destructional theories apply to these gravel terraces; and since sometimes one and sometimes the other of these causes account for them, a study must be made of each case in order to tell which is the real explanation.

The destructional cause for terraces is the more common, and there are many terraces of this origin in New York, where the rivers have excavated their valleys in the till deposits. As has been stated, many of the mature valleys of New York have been partly clogged with a till filling (p. 41); and since the ice left the streams have been busy carving new valleys, and in the course of their work they have cut terraces. The majority of small streams, as well as some of the larger ones, have such bordering plains extending parallel to them, and descending at the same rate. They can be told from others by the fact that they are made in the boulder clay, which is quite different from the stratified gravel of the gravel-filled valleys.

Ice-Scoured Plains.—This is merely mentioned in order to fill out the classification, though no plain of this nature is known to exist in the State. In passing over the surface of a moderately regular land, the glacier will plane down the hills, leaving the surface more regular as a result of the scouring; and in the course of time, perhaps, the region will be reduced to the condition of a plain by actual ice carving.

Plains of Denudation.—Where rocks are nearly horizontal, as they are throughout a large part of New York, there are sheets or strata of varying hardness, one upon another. Denudation trenches these, and streams carve valleys along their lines of flow, while rainwash and weathering more slowly wear away the interstream areas.

* Dodge, Proc. Boston Soc. Nat. Hist., Vol. XXVI, 1895, pp. 257–273.

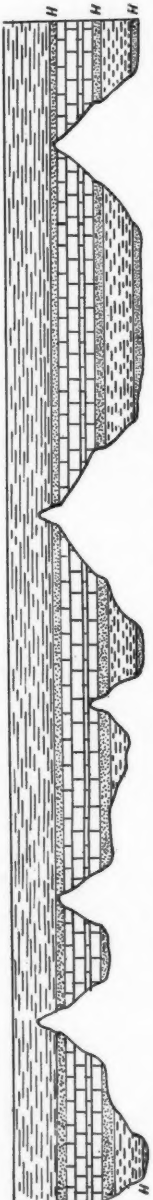


FIG. 14.—STAGE OF YOUTH OR EARLY MATURITY IN A HIGH PLAIN OR PLATEAU WITH STRATA OF VARIABLE HARDNESS (STRATA MARKED H, HARD) AND, TYPICALLY, IN AN ARID CLIMATE. CONTRAST WITH STAGE B OF FIGURE 2.

Such a region, starting perhaps as a plain, is then much dissected, so that, looked at in detail, it has little resemblance to a true plain, but is a very hilly land, especially if its elevation above the sea is great.

However, the fact that the rocks are in horizontal sheets, which are variable in their power of resistance to denudation, will make it necessary that the hill tops shall reach to a nearly uniform level. This is because, when an unusually *hard layer* is reached by the agents of denudation, further cutting is resisted so much more decidedly than in the softer strata, that the further down-cutting is held back at the level occupied by this hard horizontal bed. Hence, even if the original surface reached to different levels, the softer rocks are removed with some ease and the harder ones less easily, so that, while further lowering is slow in the case of those places that are capped by a hard layer, others that are higher, but are capped by softer rocks, will wear down more rapidly, soon reaching the level of the hard layer by which the denudation is being delayed.

In eastern New York there are plains of this origin, though they occupy rather small areas. It is this fact also which accounts for the table-lands and mesas of the plateau region of the West.* These level-topped areas, perhaps deeply dissected by cañons, stand up at a uniform level because of the protection offered by the hard layers (Figs. 16 and 17). The plains of several levels in Texas exist in horizontal rocks †; and the plains and plateaux of central and western New York also owe their present form to this condition.

The plateau of central, southern and western New York is a very hilly country, but the hills reach to a fairly uniform elevation,

* Powell Exploration, Colorado River, 1875, 1–214; Dutton, Monograph U. S. Geol. Survey, Vol. II, 1882.

† Hill, Am. Geol., Vol. V, 1890, 9–29.

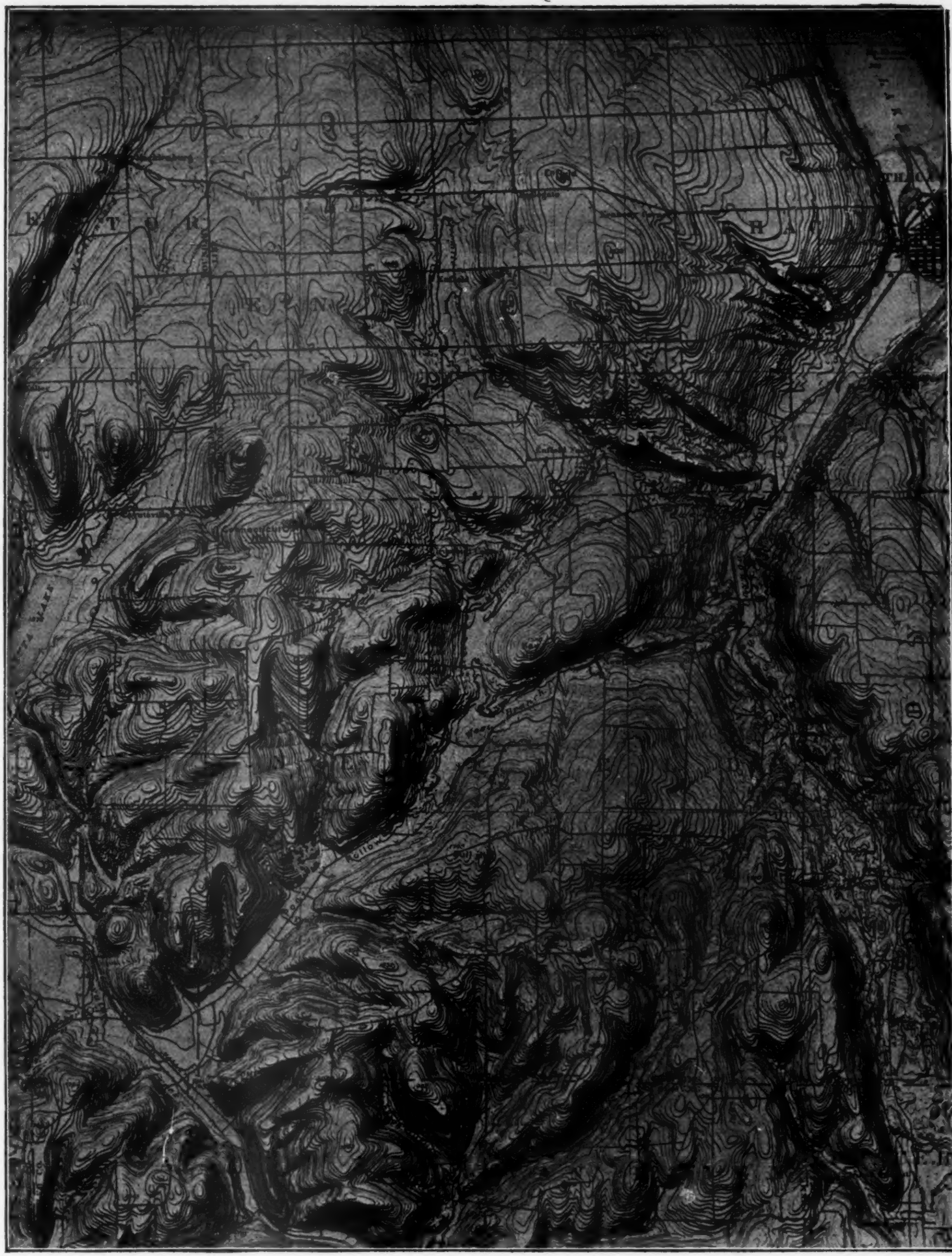


FIG. 15.—PHOTOGRAPH OF A MODEL OF THE DISSECTED PLATEAU OF WESTERN CENTRAL NEW YORK, NEAR ITHACA. (MODEL OF ITHACA SHEET (U. S. GEOL. SURVEY) BY WM STRANAHAN).

and many of them are nearly level-topped, so that, standing upon the crests of the higher hills, one looks across to other crests of nearly the same elevation. This is because the Upper Devonian

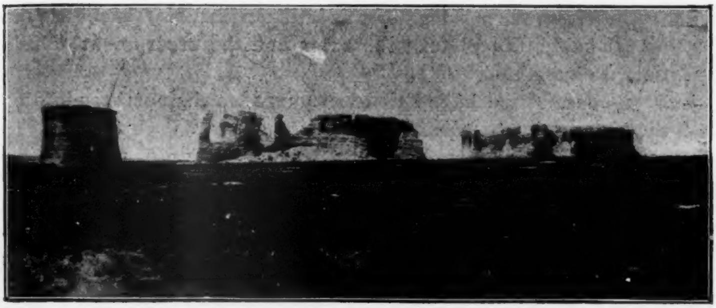


FIG. 16.—BUTTES ON THE PLAINS OF WESTERN KANSAS, REMNANTS OF A HIGHER LEVEL LEFT STANDING BY DENUDATION (PHOTOGRAPH BY PROF. WILLISTON).

strata are coarse and sandy shales which resist the agents of denudation. In western New York, in Chautauqua County, there are two plains, (1) that IN which Lake Erie is placed, which is faced on the southern side by a steep escarpment,* rising (2) to a hilly plateau region IN which Lake Chautauqua is situated. At present there seems to be no definite reason in the rock structure for this upland plateau and for the escarpment separating it from the lower plain; but in southern Chautauqua County, and across the line, in Pennsylvania, there are remnants of a conglomerate bed, now remaining upon the surface in the form of "rock cities", † where the great blocks, loosened by weathering, and perhaps somewhat disturbed by post-glacial action, now stand in confused, and often fantastic arrangement upon the surface of the land (Fig. 18).

It has seemed to me probable that the western plateau (and perhaps also that of southern-central New York), together with its north-facing escarpment, might have originated as the result of the former protection of this conglomerate stratum, most of which is now removed, the last remnants having been carried away by the ice. To test this I requested Mr. Bonsteel, Assistant in Geology at Cornell, to look about in Chautauqua County for remnants of this conglomerate to the north of the present "rock cities," and he has found fragments *in the till* in the neighborhood of Lake Chautauqua,

* Tarr, Bull. 109, Cornell Univ. Agri. Experiment Station, 1896, p. 92.

† Hall, Geol. of New York, 4th Dist., 1843, 284–285; Carll, Second Geol. Survey, Pennsylvania, Report III, 1880, pp. 57–79; Same, Report IIII, 1883, pp. 195–208.

and has gathered facts concerning the distribution of these fragments elsewhere. Therefore, either the ice has *moved northwards* in this region—not a very probable alternative—or when the glacier came upon this region some remnants of this conglomerate stratum were still left on the surface. If this latter explanation is correct, as seems probable, the plateau character and the escarpment of this section are explained.

At the base of the Lake Erie escarpment, on the northern border of the plateau just described, there is another plain, of which the bottom of Lake Erie forms a part. In New York a narrow portion of this plain extends between the escarpment and the shores of

FIG. 16.—TO ILLUSTRATE THE PROCESS OF DESTRUCTION OF A PLAIN IN WESTERN KANSAS. HILLS CAPPED BY A HARD LAYER, BEING SEPARATED TO FORM BUTTES LIKE THOSE IN FIG. 16 (PHOTOGRAPH BY PROF. WILLISTON).

Lake Erie. Upon this the City of Buffalo is situated; and in this region it is a broad, quite level plain, disappearing gradually under the lake toward the west, and losing its character toward the south as it ascends toward the high plateau of southwestern New York. It extends eastward, gradually losing its typical character as a plain, and toward the north it ends abruptly in the escarpment (Fig. 19) at Lewiston, Lockport, etc. This escarpment is determined by the presence of the hard Niagara limestone, which is also the cause for the Falls; and the plain itself, in its most typical portion, owes its levelness to the presence of this and other hard layers of nearly horizontal rocks.

Below it, at the base of the north-facing Niagara escarpment, is another plain (Fig. 19) which itself is terminated by a north-facing

bluff under the waters of Lake Ontario, the position of this being determined by the presence of the horizontal beds of the very durable Medina sandstone. This is one of the largest and most perfect plains in the State. From Lewiston to Irondiquoit Bay, and from the lake shore to the Niagara escarpment, which loses prominence toward the east, there is a wonderfully level plain crossed by the Rome, Watertown and Ogdensburg railway.

The *general* levelness of this plain is due to the rock structure; but there is a peculiar fact about it, the real explanation of which is not certain. The Niagara and Lake Erie escarpments are trenched by *deep* valleys of pre-glacial origin, the positions of which are now plainly apparent in the topography; and the two plains which these escarpments bound are also dissected; but the Ontario plain is not

FIG. 18.—CONGLOMERATE BOULDER—A PART OF THE "ROCK CITIES."

furrowed by such valleys. In its deepest point the bottom of Lake Ontario is about 738 feet below the lake level, and hence somewhat more than this below the level of the Ontario plain.

There are two prominent theories to account for the basin of Lake Ontario, one that the continental glacier carved it out of the rock, the other that it was a pre-glacial river valley changed to a lake by various causes without marked ice erosion, and chiefly by drift dams left by the ice. If the latter is true, and the bottom of Lake Ontario is an old river valley at approximately the same level which it had before the Glacial Period, the Ontario plain during this time must have been crossed by good-sized valleys of streams entering this ancient and very deep valley. Since they are now invis-

ible, it must be supposed that the glacial drift has obscured the pre-glacial irregularities, and that the plain is therefore only in part due to destructional origin, and in considerable part a plain of construction as the result of drift deposit (p. 42).

The alternative is, that the old surface to the north of the plain, on the site of the present lake, was a pre-glacial valley, whose bottom was not much lower than the present lake level, having since been reduced to the present level by some cause. There are three possible causes for its deepening,—ice erosion, faulting and folding. Of the two latter there is no proof whatsoever; but in favor of the former we have the fact that the *ice* has actually passed over this surface.* No attempt is made here to decide between these two

FIG. 19.—END OF NIAGARA GORGE SHOWING THE NIAGARA ESCARPMENT AND THE NORTHERN END OF THE UPPER PLAIN, WITH THE ONTARIO PLAIN STRETCHING NORTHWARD FROM THE BASE OF THE ESCARPMENT AND CROSSED BY THE NIAGARA RIVER BELOW THE GORGE (PHOTOGRAPH BY J. O. MARTIN).

theories, though it may be said that facts point more strongly toward ice erosion than toward the other explanation. Before a definite conclusion can be reached some detailed field work must be done along the margin of Lake Ontario.

* It is to be noted that the greatest depth of Ontario is on the southern side of its eastern half, and that the glacier, coming against the Adirondack mountain mass, was turned to either side, the western arm going southwest toward this deepest point. Therefore at the place where, according to this theory, the greatest erosion took place, there must have been a decided increase in ice movement due to this concentration of the parts of the glacier which were prevented from going due southward because of the Adirondack obstruction.

*Peneplains.**—Standing on the top of the hills in the Highlands of New Jersey, or of Southern New England, it is found that though the rocks are folded and disturbed, some of the hill tops reach to a nearly uniform level, as they do in parts of Great Britain (p. 47). In England the explanation of this fact has been marine denudation, but in this country it is ascribed to denudation in the air, or subaerial denudation. If the land remained at a nearly uniform level for a long enough time, even the highest mountains would be planed down to nearly sea-level, or to *base-level.* In proof of this is the

FIG. 20.—A VIEW ACROSS THE PENEPLAIN OF NEW ENGLAND (PHOTOGRAPH BY J. RITCHIE, JR.).

fact that New York City is situated in a hilly region which represents the last remnants of a once elevated mountain system, as do the hills of Connecticut, eastern Massachusetts and the Highlands of New Jersey.

It is difficult to account for the uniformity of level of these hills on any other supposition than that at one time they were at a lower level with reference to the sea, having been either bevelled down to a hilly lowland condition or else to the condition of a plain, a *peneplain.*† The reason for this conclusion is as follows: It is known that the country was originally mountainous, because the rocks are very complexly folded; and these contorted strata vary in hardness. Therefore, at first tilted rocks of different kinds were raised to different heights. At present, in

* Davis, Am. Journ. Sci., vol. xxxvii., 1889, p. 430; Davis and Wood, Proc. Boston Soc. Nat. Hist., 1888–1889, vol. xxiv., pp. 365–423; Davis, Bull. Geol. Soc. America, vol. ii., 1891, p. 545; National Geog. Mag., vol. v., 1893, p. 68; Bull. Geol. Soc. America, vol. vii., 1896, p. 377; Nat. Geog. Monograph, vol. i, 1896, p. 269.

† This may have been done by marine denudation or by subaerial denudation. For a critical discussion of this, with numerous references to the literature, see Davis, National Geog. Monog. Vol. I, 1896, p. 269.

many cases, they stand, still at an elevation of 1,000 or 2,000 feet above the sea, but with the hilltops reaching to a rather uniform level, while between them there are valleys of no very great width. In all the time required to lower the surface so far, the result should have been the production of valleys with great width, and hence with mature form, while between them should rise hills of different elevations. To have brought nearly all of the peaks down to a nearly uniform level, the general elevation must have been reduced even lower than now; and the fact that the stream valleys at present are *not* broad or mature, shows that there has been a rather recent uplift.

Therefore the peneplain theory is, that the mountains were bevelled to the condition of a lowland, nearly to that of a plain, during the time when the land elevation had remained quiet for long periods. The surface was then uplifted, the streams began to cut deep valleys, and the old plain to be dissected, so that now only a few remnants remain in the hilltops, which tell of a former plain by the fact that they are of nearly the same elevation. During this time of ancient base-levelling, New York was also subjected to reduction, the Adirondacks and other mountains being lowered, and the New York-Pennsylvania plateau being reduced to a plain standing nearly at sea-level. An elevation ended this period of base-levelling, and again the streams had a steep slope. Since then they have cut their valleys so deeply into the surface of the plain, and weathering has broadened them so much, that the ancient peneplain is nearly destroyed, so that, so far as New York is concerned, there is no evidence left of this former peneplain condition, though the evidence of former reduction is found in the States immediately bordering this one.

I have attempted to state this theory fairly because it is a theoretical possibility. No peneplains of large size at present exist, and there is some reason for doubting if any ever have. This is not the place for a discussion of this subject.

RECORD OF GEOGRAPHICAL PROGRESS.

ASIA.

New Rapid in the Yangtze Kiang.—M. Hulot has described before the Paris Geographical Society a new rapid in the upper Yangtze Kiang, in about 109° E. long., formed by the slipping into the river of a vast quantity of rock from its right bank during the torrential rains. The very friable upper rock strata became saturated with water and slipped away from the more solid substratum, the inclined plane upon which they rested. The vast quantity of fallen rock blocked a large part of the channel, so that the width of the river was reduced from 270 to 73 metres. After the subsidence of the river in December, 1896, the rapid that had thus been occasioned was a serious impediment to navigation between the provinces of Yunnan and Szechuen.

The Bay of Kiao-Chau and Shantung.—Dr. Frederick Hirth, in a recent lecture before the German Colonial Society at Munich, spoke of the importance of the Bay of Kiao-Chau, on the south coast of the Shantung peninsula, where the Germans are now in possession. The province of Shantung is the hinterland of the very large harbor the Germans have seized. Though Shantung is one of the most densely populated parts of China, its commerce, industry and agriculture can reach the best development only when the means of communication are improved. The rivers of Shantung are scarcely navigable for small boats. The dikes along the Yellow River, which traverses the province, are very poorly constructed, and its periodical inundations are most calamitous. But even if the river were kept within its banks by adequate dikes, it would not serve as a trading route, and railroads are absolutely necessary for the development of the province. While Kiao-Chau Bay cannot hope for a long time to rival Hong Kong, Dr. Hirth expressed the view that when there is a network of railroads in the province and a rational exploitation of its resources, Kiao-Chau Bay will become an important commercial centre for all the northern part of the Chinese empire.

Sources of the Red River, Tonkin, and Origin of its Floods.—The French possession, Tonkin, has very frequently suffered severely from the floods in the Red River, which begin in May and inundate a wide extent of country. The view has been

held that the floods are due to the melting snows from the mountains of Tibet. M. C. E. Bonin, vice-resident of France, had an opportunity, in the autumn of 1895, to visit the region of the Red River's sources in the environs of Monghoa-ting, to the south of Lake Tali, in Yunnan. He says that the region where the Red River rises is separated by many valleys from the nearest snow mountains of Tibet, the Hsueh-shan, and that, therefore, the melting Tibetan snows do not contribute to swell the Red River floods. Their real cause, he reports, is the monsoon from the south, which carries water vapor from the Gulf of Tonkin to the heights of Yunnan, where the air parts with its moisture. On account of the lack of timber and the slight permeability of the clay soil, the precipitation is poured into the river in quantities too great for the capacity of the stream bed. Hence the destructive floods.—(*Bull. Soc. de Géog.*, Paris.)

AFRICA.

Lake Rikwa Disappearing.—Rikwa, a lake of considerable extent, which since 1860 has figured upon the maps to the east of the southern end of Lake Tanganyika, has for some years been reported to be drying up, and according to the German explorer Langheld, who visited the lake early last year, the greater part of it has now entirely disappeared, and in its place extends a steppe, over which game throngs by thousands. This steppe, however, is covered by water in the rainy season. The natives told the explorer that the desiccation of the lake was almost wholly accomplished in 1891. There remains of the old lake only about 259 square kilometres in the neighborhood of Ukia and a few marshes in the southeast. Rikwa has thus shared in the general process of desiccation, which has been observed for twenty years among the lakes of Central Africa.—(*Le Mouvement Géographique*, No. 2, 1898.)

The Caverns of Mokana.—*Le Mouvement Géographique* (No. 1, 1898) briefly describes the subterranean galleries in the hills of Mokana, which were recently visited by Lieut. Leon Cerckel, of the Congo State force. These caverns are inhabited by natives, and are in the basin of the Lufira tributary of the Lualaba, source of the Congo. Captain Cameron, in his journey across Urua in 1872, heard of these troglodytes, but did not visit them. Lieut. Cerckel says that the entrances to the caverns were formed by the displacement of rock strata, some of which, resting against one another, form passageways to larger limestone chambers. In these chambers the natives store their provisions and everything

they require. The roofs of the caverns are only three to four metres in height, and the side walls have projections and recesses which make excellent hiding places and are sources of danger to enemies who may enter the caverns. The explorer visited three of these passageways and the chambers to which they led. At the principal opening Chief Mokana has built a little fort to defend the entrance.

AUSTRALIA.

Mr. Carnegie's Journey through the Great Victoria Desert.—The expedition equipped and commanded by Mr. D. Carnegie, which left Coolgardie, the mining town in south-central West Australia, on July 9, 1896, to travel north-north-east across the Great Victoria Desert to the Kimberley gold fields in the north-east part of the province, returned to Coolgardie in August last after an absence of thirteen months. (*Petermanns Mitteilungen*, No. XII, 1897.) Mr. Carnegie had three white companions, a black boy and eight baggage camels. He made two traverses of the great interior sand wastes, north and south, and a considerable area which had not previously been visited. The chief result of his work is the evidence obtained that an important part of central West Australia affords no prospect of valuable minerals, good grazing lands, or any other utility. Upon the return journey in which the party more nearly approached the eastern border of the province, they met natives who were not only physically of the Jewish type, but also possessed some of the Jewish peculiarities. They entered unknown country in about 27° S. lat., and for many days travelled among sandhills that showed no vegetation except spinifex, acacia and a few other stunted plants. They were compelled to reduce the water ration to a half pint daily for each person, but when only two gallons were left they met natives who conducted them to a remarkable waterhole.

It was a limestone cave and at the opening, three feet in diameter, they found a pole, about twenty feet long, reaching from the opening to the floor of the cave and placed there by the natives to facilitate ingress and exit. The party thus let themselves down into a large chamber from which they crawled on hands and knees through a low passage about twenty-five feet long, at the further end of which was a little stream with an abundance of excellent water. There was good grazing for camels in the neighborhood and the party remained there three days. Mr. Carnegie named this water source, Empress Soak.

On a later occasion they came perilously near suffering very severely for lack of water, but found supplies before they reached extremities. Near Mount Worsnop, in 25° 5′ S. lat., 124° 15′ E. long., they found a lagoon, about a mile in circumference, with fresh water from two to five feet in depth on which wild ducks and other water fowl were swimming. Mr. Carnegie named it Woodhouse Lagoon after Mr. Alexander Woodhouse, the companion of Mr. Carr-Boyd in his earlier explorations. Later, in an area of damp sand which yielded little water, the party spent three days in the difficult work of digging for water in the drift sand, and at a depth of about thirty feet they obtained only ten gallons, to which Mr. Carnegie added ten gallons he collected at another water source.

It was not till the party reached the neighborhood of Sturt Creek, indicated on all good maps, in the north-eastern part of the province, that their troubles from scarcity of water and fodder ceased. The change for the better came about 19° 20′ S. lat., but here they lost two of their camels which ate some poisonous plants. In a land of comparative plenty, the richly watered and grassy region of the Margaret River, Mr. Charles Stansmore, of the party, was accidentally killed by a bullet from his own rifle as he was about to fire at a kangaroo.

Returning from the Kimberley gold fields on the Margaret River, the route of the party was east of their northward track. They were disappointed in their hope to find a practicable route for cattle driving between Kimberley and Coolgardie. The fodder and water problems presented themselves anew and the region between Lake White (21° 15′ S. lat. and 128° 27′ E. long.) and Lake Macdonald (23° 30′ S. lat. and 128° 45′ E. long.) was the most difficult of the entire journey in respect of the fact that it was crossed by many ranges of high and steep sand hills. In a distance of ten miles the party had to surmount eighty-six of these hills.

DEATH OF EXPLORER GILES.—Ernest Giles, one of the explorers who were the first to reveal the vast unknown interior of the western half of Australia, after the transcontinental telegraph had been completed from Adelaide to Port Darwin, died in November last at Coolgardie, West Australia, aged fifty years. He was an Englishman, who was drawn to Australia by the removal of his family thither while he was still at school in his native land. For years he was engaged in business in Melbourne, or in stock raising, and lack of means long prevented him from carrying out his cherished project of exploring the interior. The late Baron von Müller, who did so much to promote Australian exploration, at last assisted

him to take the field, and he led an expedition which started into the unknown region west of the telegraph line near the Finke River. He was able to advance only about 300 miles from his starting point, but it was the pioneer journey in the exploration of the western interior. The expedition, though Giles's hopes of crossing the interior were defeated, had interesting geographical results, for he discovered the large, swampy area which he named Lake Amadeus, found well watered and grassy mountain ranges west of the headwaters of the Finke, and those conspicuous natural features, Ayers Rock and Mount Olga, now known as the enormous remains of an ancient geological formation.

Meanwhile two other expeditions, led by Col. Warburton and Mr. Grosse and outfitted by Sir Thomas Elder and the government of South Australia, had taken the field, and so Giles returned to his explorations as soon as possible. His west route led him from Ross's Waterhole, on the Alberga, in about 27° S. lat., across the great waste, following a direction a little north of west, and he paused at last far west of the West Australia boundary in about 126° E. long. The country traversed was most inhospitable, the toil and privations were very severe, and Mr. Gibson, one of Giles's party, missed the track and was not heard of again. Giles used horses on both these expeditions, while Warburton and Grosse using camels, proved their superiority in the exploration of Australian deserts.

For his third expedition Giles secured camels from Sir Thomas Elder, and was entrusted with the work of crossing the unknown interior, from east to west on about the twenty-ninth parallel, Warburton and Forest having already crossed the unknown further north. Giles made his real start from Beltana. On this, his most important journey, during which he twice crossed the whole width of the desert, he saw no lands of agricultural value, but merely a wretched succession of scrub, sand hills and spinifex until he reached the settled region of West Australia. Waterholes were found at long intervals, but between Boundary Dam, near the boundary of West Australia and Queen Victoria Spring, a distance of 325 miles, which he was sixteen days in traversing, not a drop of water was found. On his return route Giles struck far north-east for the headwaters of the Ashburton River, and discovered some excellent pastoral country on the way. He determined the east line of the river basin, and then plunged into the desert again, whose undulating surface of sand and spinifex was no more attractive than his southern route had proved to be. His journey ended at the tele-

graph line south of Amadeus Lake, and his fame was established for the almost unequalled extent of unknown country in Australia he had brought to light.

INVESTIGATIONS OF CORAL REEFS.

CORAL BORING AT FUNAFUTI.—Reference has been made in the BULLETIN to the expedition undertaken by Prof. Sollas, F.R.S., to the coral island of Funafuti, in the Ellice Group, to obtain, if possible, by deep boring, a solid core of rock for study with reference to the controversy as to the origin and mode of growth of coral formation. Darwin's theory accounted for coral forms on the assumption that the foundation on which they rest underwent subsidence while the reef-building coral simultaneously kept adding to the height of its structure, keeping the top within the 100 to 200 feet of the surface of the water which is demanded by the life conditions of the animal. If this theory were true, barrier reefs and atolls would be composed of coral rock masses of great thickness, for they rise from deep water. Dr. John Murray's theory, on the other hand, accounts for the formation of coral islands by considerations of growth and wave action alone, requiring no area of subsidence nor that the coral rock be more than 100 to 200 feet thick. According to this theory, the coral animal began to build upon other marine sediments or upon volcanic rock. The purpose of the boring was to ascertain whether the coral mass is very thick. Prof. Sollas' undertaking failed because quicksands prevented him from penetrating deeper than about 100 feet. The second expedition under Prof. David of the University of Sydney, N.S.W., was more successful. Boring with the diamond drill went on from late in June last till the middle of September and the bore was 690 feet deep before the work stopped. According to the *Geographical Journal* (Jan., 1898), the preliminary examination of the core tends to confirm Darwin's theory as far as this atoll is concerned. Portions of true reef have been found throughout the whole depth, though separated by deposits of coral sand and the remains of other organisms. This investigation would be quite conclusive evidence of the truth of Darwin's theory in certain areas of coral formation, were it not for the possibility that the boring was carried out on a very steep slope of volcanic rock covered by a talus of coral débris that had fallen from a reef on the summit of the rock.

PROFESSOR AGASSIZ ON THE CORAL REEFS OF THE FIJI GROUP.—A letter from Professor Agassiz (*Amer. Jour. of Sci.*, Feb., 1898) gives many details of his investigations last year among the coral reefs of the Fiji Islands. In his equipment was a diamond drill for

boring through reefs, but he did not use it for reasons that will appear. In dredging in Fijian waters, from the surface to a depth of 150 fathoms, an excellent collection of pelagic forms, particularly of crustacea and acalephs, was secured. He had heard of the results of Professor David's boring at the atoll of Funafuti, but concluded from what he saw of the Fiji Islands reef that the Funafuti boring had settled nothing, and that we are still as far as ever from having reached a general and acceptable theory of the formation of coral reefs.

Professor Agassiz went to Fiji under the impression, based upon the writings of Darwin and Dana, that he would find there a characteristic area of subsidence. He was much surprised, therefore, to find within a mile of Suva, a reef about fifty feet thick and 120 feet above sea level, the reef being underlaid by what is probably a kind of stratified volcanic mud. He found numerous evidences of extensive elevation not only on the larger island of Viti Levu, but also on other islands. It was found at Vanua Mbalavu that the northern line of islands were parts of an elevated reef forming vertical bluffs of coral rock which had been raised by the central volcanic mass of the main island to a height of over 500 feet at Ngillangillah, at Avea to 600 feet, at the Savu islands to 230 feet, and on the main island to a height of nearly 600 feet. Much evidence was also collected to show that a great part of the thickness of the elevated reef has been eroded so as to reduce it in some places to the level of the sea, or to leave at other places bluffs or islets.

From this evidence he believes that the corals of to-day have played no part in the shaping of the circular or irregular atolls scattered among the Fiji Islands, and that the recent corals living upon the reefs, either of the atolls or of the barriers, form only a crust of very moderate thickness upon the underlying base which may be either a flat of an eroded, elevated reef or of a similar substructure of volcanic rocks. The Fiji Islands are not situated in an area of subsidence, so that the theory of Dana and Darwin is not applicable to the atolls there, and borings would be futile in that group. Of course there is nothing new in finding coral reefs in an area of elevation, but Professor Agassiz is of the opinion that the evidence now collected emphasizes the fact that there is no general theory of the formation of coral reefs, either barrier or atolls, of universal application. Each district must be examined by itself.

PHYSICAL GEOGRAPHY.

Relief of the Terrestrial Crust.—The well-known German geographer, Dr. H. Wagner, Göttingen, has printed in the *Beiträge*

zur Geophysik an interesting paper upon the relief of the terrestrial crust. He divides the crust of the earth into five regions, as follows:

1. The *culminating surface*, occupying 6 per cent. of the land area and comprising the lands whose altitude is over 1,000 metres above the sea: the mean height of this region is 2,000 metres above sea-level.

2. The *continental plateau*, embracing lands whose altitude is comprised between 1,000 and 200 metres; it occupies 28.3 per cent. of the terrestrial surface and has a mean altitude of 250 metres.

3. The *continental slope*, from the altitude of 200 metres above the sea to the depth of 2,300 metres below sea-level, covering 9 per cent. of the crust of the earth, with a mean depth of 1,300 metres below sea-level.

4. The *oceanic plateau*, lying from 2,300 to 5,000 metres below sea-level, and occupying not less than 53.7 per cent. of the crust of the earth with the mean depth of 4,100 metres.

5. Finally, the *most depressed area*, comprising the parts of the earth's crust that are more than 5,000 metres below the sea level. They form 3 per cent. of the crust of the earth and have a mean depth of 6,000 metres below sea-level.

The mean level of the crust of the earth, according to the calculation of Dr. Wagner, is 2,300 metres below the level of the sea. The surface lying above this mean level is 43.3 per cent. of the total surface. The total land surface does not exceed 28.3 per cent., leaving 71.7 per cent. for the water surface of the earth. The mean altitude of the continents is 700 metres. These figures are only approximate, first, on account of the difficulty of calculations of this sort, and, second, on account of our imperfect information concerning the polar regions still unknown, and which represent 4 per cent. of the surface of the globe.

EFFECT OF MOUNTAINS ON CLIMATE.—In the new edition of his "Handbuch der Klimatologie," Dr. Julius Hann, meteorologist, and the leading authority on climate as affected by mountains, says that every spot along the northern Mediterranean shores, that is famed for the mildness of its winter climate, owes this entirely to its immunity from cold winds which are invariably shut out by a mountain range. Treating of the climatology of the tropics, he shows that data for the interior of tropical Africa are fragmentary, that scarcely any data are yet accessible for the entire tropical

region of Brazil, and very little for the tropical Pacific islands. In the parts of his work dealing with east Siberia and the United States, he shows how the differences in the trend of mountain ranges affect climate. The chain in the west of the Americas lies close to the coast and sweeps west towards Bering Strait, while in Europe, the Norwegian mountain line turns to the east. Accordingly, the influence of the Pacific Ocean is reduced to a minimum in the New continent while the influence of the Atlantic extends far inland in the Old continent. He compares the United States with east Asia, and finds that the States are exposed to the visitation of icy north winds owing to the absence of crossing mountain ranges of any considerable altitude. But in Asia, high mountains and table-lands check the outflow of chilled air from the Siberian centre of cold about the valley of the Lena.—(*Nature.*)

THE CLIMATIC CONTROL OF OCCUPATION.—Mr. R. DeC. Ward, Instructor in Climatology in Harvard University, has a short article on the climatic control of human occupations (*Jour. of School Geog.*, Dec., 1897), with particular reference to Chile. In the trade-wind latitudes, on the western or leeward coast of South America, are the dry and barren regions of Peru and Chile. Between lat. 4° and 30° S., the coast strip is either practically rainless or has a very small rainfall. But south of lat. 30° S., the region of prevailing westerly winds begins and the rainfall increases more and more with increasing latitude until, about lat. 38° S., the zone of heavy rainfall begins.

These great differences in rainfall exercise an important control over human occupation, especially such as are connected with agriculture. In the northern provinces of Chile agriculture on a large scale is impossible, and there is vegetation only in small areas where irrigation is practicable. In the far south, where the abundant rainfall is favorable to forest growth, lumbering plays an important part in the life of the people, and that, with fishing, is the chief occupation. North of the region of very heavy rains, between latitudes 27° and 41° S., there is neither an excess nor a deficiency of rainfall, and agriculture is the chief occupation, though irrigation is necessary in many parts. North of latitude 27° S. the barren nitrate fields replace the green valleys and the vine-clad hills of the middle zone further south, and the nitrate industry and mining are almost the sole occupations of the people. The nitrate ports have to import almost everything in the way of food, including a large number of cattle that come from the agricultural zone, affording an interesting illustration of the control of

climate over imports. Mr. Ward avoids the not uncommon liability to overestimate the influence of one factor at the expense of other causes that determine the nature of occupations. Thus, in Chile, it is the geology of the northern part of that country, combined with past and present climatic conditions, that determines the presence of the immensely valuable nitrate and other deposits. But in this region, human occupation is peculiarly controlled by climatic conditions, for abundant rainfall there would probably destroy the nitrate industry, and farming would become one of the chief industries.

THE HARVARD METEOROLOGICAL STATIONS IN SOUTH AMERICA.—In a letter from Mr. R. DeC. Ward, printed in *Science* (January 21, 1898), he describes at length the meteorological stations established in Western South America, under the auspices of the Harvard College Observatory at Arequipa, Peru. These stations are roughly in a north-south line, extending from the seacoast across both ranges of the Cordillera and down to 3,300 feet above sea-level in a valley at the headwaters of the Amazon River system. The station at Mejia, on the Pacific, nine and a half miles from Mollendo, is fifty-five feet above sea level and 420 feet from the sea, surrounded by desert, and is giving data concerning the conditions of the desert belt when its climate is modified by the proximity of the ocean; the next station is inland, at La Joya, forty miles from the ocean, on a pampa 4,141 feet above sea-level, where desert meteorology, including mirages, dust whirls, etc., are being studied. The central station is at the Observatory at Arequipa, eighty miles from the ocean, and in close proximity to some high mountains, whose meteorological conditions are proving an interesting study. The fourth station is thirty miles northeast of Arequipa, at an elevation of 13,400 feet, amid volcanic sand and ashes, where readings of the wet and dry-bulb thermometers are made whenever a visit to the place is possible. Above this station, on a flank of the Misti, at a height of 15,700 feet, is Mont Blanc station, so called because its altitude and that of the observatory on the summit of Mont Blanc are almost exactly the same. The highest meteorological station in the world is that on the summit of the Misti, 19,200 feet above the sea. The observers have recently been able to visit the instruments on this lofty spot only about once a month, and they usually suffer from mountain sickness when they make the ascent. The seventh station is at Cuzco, in a valley between the east and west ranges of the Cordillera, 11,378 feet above

sea-level; and the last station, at Echarati, is on the east slope of the east range of the Cordillera at the eastern limit of civilized Peru. Thus Harvard has established a fine series of stations in that hitherto meteorologically unknown country, cutting diagonally across the desert belt of Peru, and extending through a region of increasing rainfall, down to the well-watered valley of Urubamba, which belongs to the Amazon watershed. A large number of the observations obtained at these stations are now being tabulated for publication.

THE HARVARD GEOGRAPHICAL MODELS.—At the meeting of the Geological Society of America, at Montreal, three of the series of these models were described and exhibited, by means of lantern slides, by their designer, Professor W. M. Davis, of Harvard University. They were constructed by Mr. G. C. Curtis, and the purpose they are meant to serve is to illustrate a number of geographical forms in their genetic relationship. The three models exhibited represent a mountainous region descending to the sea; the same area after depression whereby the shore line has become very irregular; and the same area after elevation whereby a coastal plain has been added to the land area.—(*Science*, January 21, 1898)

GENERAL.

FORESTRY IN CANADA.—The Canadian Government has decided to maintain forest reserves in Manitoba and the North West. The heavier timber belts will be withdrawn from settlement and the young trees preserved as the starting point of future forests. In the Turtle and Moose Mountain regions and in some other districts special measures will be taken to protect the reserves from molestation. Last winter Parliament voted a fund to be used to guard timber reserves, as far as possible, against fires.

PROFESSOR GUIDO CORA LEAVES TURIN.—After sixteen years as Professor of Geography at the Royal University of Turin, Professor Cora has resigned in order to devote himself entirely to scientific research in geography and the related sciences. He has removed to Rome and will hereafter issue his periodical, *Cosmos*, from that city.

FLOODS OF THE MISSISSIPPI RIVER.—The Department of Agriculture has issued a *Bulletin* by Mr. Park Morrill, in charge of the river and flood service in the Weather Bureau, on "Mississippi River Floods." The *Bulletin* reviews the physical characteristics

of the Mississippi basin and river and briefly covers the entire regimen of the river both in its normal condition and in flood. It is illustrated with charts and tables giving phases of the precipitation and the results of inundation in the most notable flood years. Mr. Morrill writes that in the floods of the past quarter century the western tributaties have not played an important part. The great source of floods is the Ohio basin, with its steep slopes from the crest of the Alleghanies, upon which fall the heaviest rains of spring, at a time when the normal rise of the lower Missippippi brings the river almost to the danger line from Cairo to the Gulf. In the greatest floods the heavy rainfall over the extensive swamp region from the mouth of the Ohio to the Gulf of Mexico is also an important factor. The Upper Mississippi is third in importance as a factor in producing floods. It never discharges a volume sufficient of itself to produce a flood, but rising later than the Ohio, it serves to prolong the high water and thus to increase the overflow.

ROCKALL.—A series of papers on the islet of Rockall has been published by the Royal Irish Academy. Rockall is only about 70 feet high and 300 feet in circumference, a small steep rock, rising on a bank of small extent from the abysmal waters of the North Atlantic, about 260 miles north of Ireland in 57° 36′ N. Lat., 13° 14′ W. Long. The recent revival of interest in Rockall is largely due to Mr. Miller Christy, who has called attention to its eligibility as the site of a meteorological station. The rock has often been mistaken for a ship. The shallow bank on which it stands is about 100 miles in extent from north to south and 50 miles from east to west, with less than 100 fathoms of water over it. It is frequented by fishermen from Grimsby and the Færoes and has high repute as a fishing ground. Investigations made last Summer seem to show that it will hardly be available as a meteorological station on account of the difficulty of surmounting the steep rock.—(*Geog. Jour.*, Jan. 1898.)

WASHINGTON LETTER.

WASHINGTON, D. C., FEBY. 15, 1898.

WASHINGTON ACADEMY OF SCIENCES.—One of the most important steps toward the promotion of science and the strengthening of the agencies of investigation through unity of organization has been taken in the formation of an Academy of Sciences. There is probably no city in the country in which there is such a large group of investigators as in Washington, owing to the development there of the many bureaux and offices of the Government having to do with lines of original research. The condition of the scientific societies, owing to various causes, has been somewhat anomalous, there being a considerable number of independent organizations, each with its own administrative officers and publications, having little to do with neighboring societies. The lack of unity has been a matter of regret, as it is obvious that due recognition has not been given to the value of the work in the scientific societies from the fact that the results have been greatly diffused through many minor channels.

The origin of this peculiar condition of disintegration has been attributed to the traditions of the first of the organizations, the Philosophical Society. This adopted a somewhat exclusive view of scientific work, being extremely careful in the character of its membership and not attempting to popularize or attract others to its meetings. From time to time it neglected opportunities of forming sections within which topics of special interest might be discussed, and it may be said forced the more active and energetic of its members to seek other channels for reaching the public. As a consequence the Anthropological Society broke away from it, and in turn other organizations have been formed covering various fields of science, as shown by the names, until there now exist seven well recognized scientific associations, known as the Anthropological, Biological, Chemical, Entomological, Geological, Geographic, and Philosophical, besides others of less note. The growth of some of these societies, especially the more popular, the Anthropological and the Geographic, has been rapid, while on the other hand the Philosophical has declined in membership, and has come to be regarded as composed mainly of mathematicians and physicists.

Attempts have been made to bring about such a closer union,

that economy of effort and money might be secured in administration and publication. As a result of the movement a Joint Commission was formed in February, 1888, its functions being advisory. In 1895, believing that fuller coöperation was desirable, this Commission, originally composed of three delegates from each society, was enlarged to include the officers and administrative Boards of all the component organizations. This new Board, consisting of about eighty men, was found to be cumbersome and not wholly efficient; therefore, after considerable discussion, the plan was adopted of forming an entirely new body to be known as the Washington Academy of Sciences, to take the place of the old Joint Commission of the Scientific Societies, and to perform other functions.

The method of procedure has been for the old Joint Commission through a special committee to draw up an act of incorporation and set of by-laws. When these had been agreed upon they were submitted to the component societies and ratified. The problem of choosing the original members of the new institution developed many plans, but out of these one was adopted which proved satisfactory. Each member of the Joint Commission was requested to prepare a ballot of one hundred names; out of these the seventy-five having the highest number of votes were chosen to form the nucleus of the Academy.

The objects of the Academy are: the promotion of science with power to acquire real estate, to hold meetings, publish documents, conduct lectures, assist investigation, maintain a library, and in general transact any business pertinent to an academy of science. The particular function of the Academy has not yet been determined upon, but it is probable that at first its energies will be bent toward the publication of results of original research, or possibly the reprinting of papers of peculiarly meritorious character, or the conducting of the series of Saturday afternoon lectures.

On Wednesday, February 16, the Washington Academy of Sciences was formally organized and the following officers elected: President, J. R. Eastman; Secretary, G. K. Gilbert; Treasurer, Bernard R. Green; Managers, Frank Baker, A. Graham Bell, F. W. Clarke, C. Hart Merriam, H. S. Pritchett, George M. Sternberg, Charles D. Walcott, Lester F. Ward, and Carroll D. Wright.

River Pollution.—The increasing pollution of the waters of the Potomac River is a matter of deep concern to the inhabitants of the city of Washington owing to its marked effect upon the health not only of the citizens but also of visitors to the national capital.

The problems here are similar to those encountered to a greater or less degree in many other cities, according to the geographic environments. In the case of the city of Washington water is obtained directly from Potomac River at a point just above the Great Falls, where the river plunges over a succession of cataracts and finally descends to the tidal estuary extending above Georgetown, or West Washington as it is now called.

The Potomac receives its waters from rainfall upon the Allegheny Mountains, the drainage basin being within portions of the States of Pennsylvania, Maryland, West Virginia and Virginia. The greater part of the tributaries flow in a northeasterly direction through limestone valleys between high, sharp ridges of the harder sandstone. The waters coming from the hills or mountains of sandstone or of crystalline rocks are as a rule clear and pure, excellent for domestic purposes, but when the smaller streams enter the fertile valleys, whose soil is largely the residue left after partial solution of the calcareous, they become discolored and in times of storm the streams carry heavy burdens of mud. Thus the water in Potomac River is often of a yellowish tinge and almost opaque, owing to the load of exceedingly fine clay held in suspension.

In addition to the natural impurities due to washing of the agricultural soils there are, however, more serious causes of apprehension in the artificial pollutions, whose quantity is growing larger each year. In the more northerly parts of the basin, especially in western Maryland, are many coal mines, the water from which is drained or pumped into creeks tributary to the Potomac. This water as a rule contains, besides iron, a considerable quantity of sulphuric acid in various combinations, sufficient in quantity to poison the fish and to be a source of annoyance, if not of injury, to the inhabitants of smaller towns. Many tanneries and pulp mills manufacturing paper discharge their refuse into the flowing waters and sawmills throw the dust out where it may be washed away. It is probable that the acids from the mines neutralize some of the alkalies discharged by the pulp mills, and that mingled in the water new and harmless compounds are formed, many of the deleterious substances being destroyed during the time that the stream is freely exposed to light and air.

With the increase of agriculture in the fertile valleys of the Shenandoah River and the development of manufacturing industries all along the stream, the towns increase in size and new villages spring up. Each of these in time introduces systems of water supply with accompanying sewage, the ordinary form of disposal

being to discharge this into the nearest running water. Passing downstream this is greatly diluted and, in case of refuse from manufacturing establishments, it is often difficult to detect the presence of impurities at points ten miles or more below the place of discharge. Chemical and bacteriological analyses often yield negative results owing to the degree of dilution, but from the fact that pathogenic germs are not often found in water samples it is hardly safe to assume that they may not be present and active. It is well known that these are continually entering the waters of the Potomac River at various points with the sewage and waste materials, and it is hardly probable that in a journey of from one to four days' duration their virulence is entirely destroyed.

The quantity of water carried by the Potomac River above Great Falls in flood ranges from 50,000 cubic feet per second up to 200,000 cubic feet per second, or even more. These floods, of irregular occurrence throughout the first half of the year, are of short duration, the water usually subsiding in a few days to a volume of from 3,000 to 5,000 cubic feet per second. In the months from August to November inclusive the discharge may sink to, or below, a thousand cubic feet per second. At such times there is the greatest need of water, and at the intake of the Washington Aqueduct the quantity may be from 6 to 9 per cent. of that in the entire stream.

During the periods of protracted drought the water is clear, since it comes mainly from springs in the limestone regions and is not discolored by mud washed from the fertile fields. To the eye the clear water of summer is preferable to the turbid material borne by spring freshets, but the proportion of invisible organic matter, especially of pathogenic germs, may be relatively great.

The case of Washington may be cited to illustrate the necessity of action being taken by Congress in the matter of protecting the waters of interstate streams. In some portions of the country State lines have been drawn so that drainage basins lie within a single commonwealth, and it is possible for the legislature to enact measures preventing the pollution of rivers from which water is taken for municipal or domestic purposes, but as a rule topographic boundaries have been ignored and State lines have been laid down upon the map, cutting the catchment areas so that streams cross and recross State boundaries. Thus, as in the case of the city of Washington, the source of water-supply may lie in several States. There is here an object lesson before the eyes of our national legislature enforcing the contention that Congress must

for the general welfare of the people provide broad legislation, permitting the protection of the streams which pass from one State into another.

Progress on the New York State Map.—The great map of the State of New York, as planned, will consist of about 250 atlas sheets. Of these, 75 have been engraved and published, and 14 additional are in various stages of progress of drawing and engraving. During the field season of 1897 there have been 10 new sheets surveyed and 4 old sheets revised. These latter were those showing the city of New York. These were prepared about ten years ago and since that time notable changes have taken place in the suburban towns, such as to necessitate a complete revision. The result of this re-survey will be shown in a map of Greater New York—one of the most detailed and important maps yet issued through the coöperation of the State with the National Government.

The list of publications of the Geological Survey gives the names of the sheets now available. In addition to these, the field work on the following has been completed: In the Adirondack region—Newcomb, Thirteenth Lake, Indian Lake, Old Forge and Remsen; in the centre of the State—Utica, Cazenovia, Tully, Skaneateles, Auburn and Moravia; in the southwestern part of the State—Olean and Salamanca; and along Lake Ontario—Hamlin and Brockport. In the completion of the map of Greater New York the Oyster Bay and Hempstead sheets have also been finished. The total expenditure from all sources last year is stated to have been $32,228.

Boundary Line between Idaho and Montana.—In the Sundry Civil Bill, approved June 4, 1897, an appropriation was made for surveying the boundary line between Idaho and Montana, beginning at the intersection of the 39th meridian west from Washington (or 116° 3′ 0″ 60 west from Greenwich), with the boundary line between the United States and the British possessions, then following this 39th meridian south until it reaches the summit of the Bitter Root Mountains, this line being in all about 70 miles in length. It lies within some of the wildest and least known portions of the United States and crosses a number of large rivers. In locating the position of the 39th meridian a base was taken in the vicinity of the city of Spokane, Washington; from known points here triangulation was continued westward to the summits of the Bitter Root Mountains, and thence in a belt having a general northerly and

southerly position, certain points being determined near the designated meridian.

The field season proved to be less propitious than usual, and great trouble was experienced from the smoke from burning forests. A sufficient number of points, however, were determined so that it will be practicable during the season of 1898 to locate positions for the monuments marking the meridian. Temporary marks are to be established on preliminary or random lines and when the true line has been determined monuments will be erected. The more important of these, particularly near the Northern Pacific Railway, the Great Northern Railway, and the Kootenai River, are to be monoliths 6 feet in length, at least 10 inches square, set 3 feet in the ground and with the words "Idaho" and "Montana" cut on the west and east sides respectively. Similar monuments are to be placed, if possible, at the international boundary and at the summit of the Bitter Root Mountains, while intermediate positions will be shown by wrought-iron posts 6 feet in length and with a brass cap upon which is inscribed a north and south line with the words "Idaho" and "Montana" on the respective sides. Beneath each of these posts are to be buried charcoal or vials filled with ashes. Where the point to be marked falls upon a rock surface holes are to be cut and copper bolts inserted.

Distances along the line are to be measured by chaining, or by stadia, where the slopes are so precipitous that they cannot be crossed. The photographs taken along the course of this boundary exhibit a country of extraordinary roughness and complication of structure. Range after range of tangled mountain masses appear with narrow crests and precipitous sides separated by narrow gash-like valleys. Near the south end of the line is Clarks Fork River flowing to the west into Lake Pend d'Oreille, and to the north of this the Kootenai River which, flowing in a northwesterly direction from Montana, crosses a corner of Idaho and passes north into British territory to form with Clarks Fork the Columbia River.

Survey of the National Forest Reserves.—The forest reserves of the United States are, with the exception of the Black Hills, situated in high mountainous regions, with altitudes ranging from 5,000 to 13,000 feet. They are at a considerable distance from ordinary means of transportation, and the roads or trails leading to or through them are traversed with considerable difficulty. Storms are frequent and during the summer months when snow does not fall the smoke from forest fires often obscures the vision. The surveys of these areas have, therefore, been prosecuted with

great difficulty and with more or less actual privation on the part of the men engaged in the work. In some cases it has been necessary for the surveyors to pack upon their backs their blankets, instruments and supplies, it being impossible to take horses or mules over the route traversed.

The survey of the reserves has been divided into two classes of work, the first being the location of points of control and mapping of the surface of the country in order to prepare maps similar to the ordinary topographic sheets. The second class of work has been the examination of the character of the forests by men specially qualified, and selected for their known ability without regard to political affiliations. These special field assistants obtained information concerning the amount, species, size and distribution of the timber, representing these facts diagrammatically upon the maps. These also show the extent of timber cutting, the damage done by fire, and the location of farming lands. The reports accompanying these maps describe the character of the undergrowth, the soil, the extent and possible value of the mineral lands, the demand for timber and the facilities for taking this out. A discussion is also had of the effect upon the forests of the pasturage of cattle and sheep, particularly of the latter.

The principal areas surveyed during 1897 have been the Black Hills Reserve in South Dakota, the Big Horn and Teton Reserves in Wyoming, the Lewis and Clark and Flathead Reserves in Montana, the Uinta Reserve in Utah, the Bitter Root Reserve, lying partly in Montana and Idaho, the Priest River Reserve in the extreme northern portion of Idaho, and the Washington Reserve in the northern part of the State of Washington. The largest force of men was centred in the Black Hills, there being on December 1 an aggregate of 57 surveyors and assistants in that region. The triangulation of the whole area was completed and about two-thirds has been mapped. During the progress of the work surveys were extended along 1,190 miles of road and 451 miles of spirit level lines were run. The land survey work cost less than $10 per lineal mile, including the expense of instruments and outfits. The entire forest area within the reservation and also portions outside have been examined and the data placed upon the topographic maps.

In contrast to the work in the comparatively well settled Black Hills region has been that carried on in the reservations in northern Idaho and Montana. Here there are few roads or trails and little if any mapping has been done. It was necessary to lay out a scheme of triangulation from the nearest astronomic station, that at Helena,

Mont. The points thus obtained furnish a control from which mapping will be carried on during the season of 1898. Without these maps it has been found impracticable to examine the public forests. The country is an almost unknown region, apparently consisting of complicated ranges of mountains with serrate peaks and separated by narrow, rocky valleys.

In order to make a beginning in the survey of the Bitter Root Forest Reserve it has been necessary to select an astronomic station. The location chosen was in the town of Hamilton, Mont. The latitude was obtained by observations on sixty pairs of stars, and the longitude by time observations and telegraphic exchange of clock signals with Washington University at St. Louis, Mo., on five nights. A permanent meridian mark has been set one-half mile south of the astronomic pier. A base line of 57 miles has also been measured with a 300-foot tape. From this, triangulation was expanded over an area of 6,500 square mlles, furnishing points of control sufficient for a reconnaissance map. A detailed survey has been made of 600 square miles and the remainder of the reserve has been shown by a reconnaissance sketch, sufficient for the purpose of exhibiting the extent of the forest areas and of the portions burned over as well as those naturally bare of timber. The mineral areas and farming lands have also been defined upon this map.

The Washington Forest Reserve in the northern part of the State of that name embraces some of the most attractive mountain areas of the country, both from the ruggedness of the topography and the picturesqueness of the flora. The high snow-clad summits of the Cascade Range send down numerous glaciers which penetrate the dense forests, cutting broad, white lines through the evergreen trees and giving rise to scores of cascades often bounding over cliffs hundreds of feet in height. In the narrow valleys are many lakes, some of them of extreme depth. The best known of these is Lake Chelan, nearly 70 miles in length and from one to four miles in width. The deepest point in this lake is about 200 feet below sea-level, the depth being approximately 1,300 feet. About 400 square miles has been mapped in the vicinity of this lake, a base line for this purpose having been measured near the shore. Level lines were continued from the Columbia River and permanent bench marks established at the head and foot of the lake, the water surface being found to be 1,108 feet above tide. Levels were also continued to the summit at Cascade Pass, the altitude being 5,423 feet.

Observations were made within this reserve by which the extent and variety of the timber areas have been defined and the lands

more valuable for agriculture than for timber have been outlined. On the western side of the Cascade Mountains field work on the survey of the reservation was greatly retarded by alternations of storms and smoke from forest fires. Topographic surveys were extended over about 500 square miles and level lines over the roads and trails. A connection was also made by triangulation with the Ellensburg base on the east side of the mountains.

While various surveys and examinations of many of the public forests have been pushed in the field, attempts have been made by Mr. Henry Gannett to bring together all of the uncollected or unpublished data concerning the lumber resources. Timber cruises have been made by railroads and land companies in areas scattered all through the forested region, giving facts which, when brought together, will for the first time enable the preparation of estimates of the amount, character, and distribution of merchantable timber of the West, and give to the people of the United States a true conception of their property holdings in timber lands. N.

MAP NOTICES.

BY

HENRY GANNETT.

Since our last notice the U. S. Geological Survey has published nine sheets. Three of these are in New York State, and, as is the case with all the work done in the State, they are upon a scale of 1:62,500, the relief being expressed by contours with an interval of 20'. These three sheets are in the northwest portion of the State and are designated as Medina, Albion and Oak Orchard; the last named being on the south shore of Lake Ontario, the others being respectively south and southwest of it.

One sheet, Apishapa, upon a scale of 1:125,000, and with a contour interval of 25', represents an area of nearly 1,000 square miles upon the plains of Colorado. The northeastern part of this area consists of typical plains with their undulating surface. The remaining portion, however, is a plateau region, in which the streams have cut heavy cañons, and whose surface is broken with buttes and mesas.

In Idaho is one sheet, Hailey, upon a scale of 1:125,000, with a contour interval of 100'. This represents a portion of the Salmon River Mountains, including the most rugged and highest part of that system. Hyndman Peak, which stands within this area, is, so far as known, the highest peak in Idaho.

In Washington is one sheet, Seattle, upon a scale of 1:125,000, with a contour interval of 50', which includes the city of that name, with the adjacent shores of Puget Sound, and the glacial hills and valleys upon its eastern shores.

In Oregon is one sheet, Portland, upon a scale of 1:62,500, with a contour interval of 25'. It includes the metropolis of Oregon, with the lower course of Willamette River, and a portion of the Columbia.

In California are two sheets, both upon a scale of 1:62,500. One in the northern part of the State includes Mount Shasta. Indeed, the summit and slopes of this great mountain occupy almost the entire sheet. An examination of this map impresses the reader with the newness of the mountain; indeed, since it was erected stream erosion has made but little impression upon it, and little of its substance has been wasted away. The cañons and

gorges upon its sides are of slight dimensions. The other sheet in California lies east of San Francisco Bay, and is known as Concord. It includes a portion of the coast ranges.

New map of California and Nevada, 1895, published by Whitaker & Ray Co., San Francisco, scale 12 miles to 1"; relief is expressed by crayon shading.

Of the map of Sweden, published by the general staff, upon a scale of 1:200,000, two sheets have been issued. Upon these the relief is expressed by a combination of hachures and contours.

That the Government survey of Mexico is progressing is evidenced by the fact that four additional sheets have appeared. These are on a scale of 1:100,000, and relief is expressed by contours with an interval of 50 metres.

A relief map of northern Sweden has appeared. It is published upon a scale of 1:500,000. Degrees of elevation are shown by a series of tints of yellows and browns.

Of the map of the Netherlands, upon a scale of 1:25,000, twenty-five additional sheets have appeared. Upon these, relief is expressed by hachures, and the character of the vegetation and of the crops on cultivated land are expressed by colors.

Among the Dutch maps should be mentioned also the topographical map of Bantam Residency, Java. This map is on a scale of 1:100,000, and is composed of nine sheets, published in 1897. Relief is expressed by hachures, and by colors the character of the vegetation, of the soil and of different kinds of crops are represented.

The Geological Survey of England and Wales has published four sheets of an index map. This is, in effect, a general geological map. It is on a scale of four miles to an inch.

Of the geological map of Würtemberg four additional sheets have been issued, upon a scale of 1:50,000.

The Geological Survey of Japan has published an agronomic map, upon a scale of 1:100,000, showing by colors the character of the soil and of the natural and cultivated products.

Among the geological folios recently issued by the U. S. Geological Survey, is one of an area in southern Colorado, about the City of Pueblo, known as the Pueblo Folio. The maps represent an area of about 1,000 square miles, lying north, south and west of the city.

Besides the maps representing topography, areal geology and economic geology, which are commonly comprised in these folios, there is one representing, by shading, the rock deformations within

the area, the folds and faults, but the feature that particularly distinguishes this folio is a map showing the distribution of artesian water under this area. It represents, by colors and depths of color, the areas in which (*a*) flowing wells can be obtained, (*b*) pumping wells, and (*c*) areas in which artesian water cannot be obtained. Moreover, it shows, by means of a species of contour lines, the probable depth at which, within the artesian areas, water will be obtained.

In an arid region like this, where an artesian well is as valuable as a gold mine, such maps have a direct economic value almost beyond calculation.

BOOK NOTICES.

L'Extension du Système Décimal aux mesures du Temps et des Angles. Théorie, Applications Scientifiques et Industrielles par J. de Rey Pailhade, Ingénieur Civil des Mines. Paris, Gauthiers-Villars & Fils, Imprimeurs-Libraires du Bureau des Longitudes, de L'École polytechnique, 55 Quai des Grands-Augustins, 55. Toulouse, Gimet-Pisseau, Libraire-Éditeur, 66, Rue Gambetta, 66. 1897. 8vo.

M. de Rey-Pailhade works without ceasing at his labour of love, though well aware of the obstacles in his way. "For the time," he says, "the one object must be the adoption of the system for science, so as not to alarm the public, which is the sturdiest supporter of routine."

He has made converts. The Toulouse Chamber of Commerce adopted in April, 1897, a resolution in favour of the application of the decimal system to the division of time and of the circle. His table for simplifying the reduction of minutes and seconds to decimals of the hour has met with favour in Mexico and in Greece. It is true that Mr. Holden, of the Lick Observatory at Mt. Hamilton, does not see the immediate necessity of a change; but curiously enough, says M. Rey-Pailhade, his astronomical assistants, Messrs. Aitken and Schaeberle, make use of the decimal division of the day and the degree.

The conclusion reached is that the decimal division of time is a necessary reform and that a few years will see it established, if the needed instruction is given in the schools, and scientific societies and writers add, in parenthesis, the decimal value of the minutes and seconds as now used: *e. g.*, 8.30 P.M. (decimal time $85^{\text{cés}}$, 4). The Geographical Society and the Society of Natural History, of Toulouse, have practised this reform since the year 1894.

Les Restes de la Civilisation Hindoue à Java, par Jules Leclercq, Correspondant de l'Académie Royale de Belgique. (Extrait du Bulletin de l'Académie Royale Belgique.)

M. Leclercq had cherished the idea of approaching the great temple of Boro-Budur by moonlight, but the moon was hidden by dense clouds when he reached the ruins, and it was in the early morning that he climbed the steps to the top of the monument.

Thence he looked down on the chaos of terraces and cupolas, of

galleries and cornices, set in the wonderful verdure of the valley, and far away to the tops of the mountains just touched by the rays of the rising sun. A scene to be remembered.

Neither Angkor Wat, nor temple of India equals, in M. Leclercq's judgment, the great Buddhist ruin, the work of a genius endowed with surprising vigour of conception.

Boru-Budur and Tjandi Mendoet are the two purely Buddhist temples in Java; the other ruins belong to the followers of Brahma. The most remarkable is the group of Parambanan, discovered 100 years ago. They are covered with sculptures representing scenes of the Hindoo mythology.

The Javanese, though Mohammedans, offer incense and flowers to these figures of their ancient gods, and M. Leclercq saw a woman bow down before one of the images and dedicate her child to it.

It is not easy to agree with the author's closing denunciation of Islam as the foe of architecture:

> "This deadly religion, imposed by the sword, has destroyed the creations of genius and the masterpieces of art in all the countries of the ancient world into which it has penetrated; from the shores of the Bosporus to those of the Indian Archipelago, the Koran reigns over ruins."

Volcanoes of North America: A Reading Lesson for Students of Geography and Geology, by Israel C. Russell. The Macmillan Co., 1897. $4. pp. XIV + 346.

The most recent of the monographs for teachers from the pen of Prof. I. C. Russell considers the Volcanoes of North America, and is a valuable addition to geographic literature. The previous volumes on the Lakes and Glaciers of North America were devoted to topics concerning which the available literature was large but much scattered. In the volume at hand the author has given us a treatise on a topic whose literature has not been readily available, and the volume fills, as it were, a greater want than either of its predecessors.

The book opens with a lengthy and interesting account of the Types of Volcanoes, giving us the basis of primary classification, according to origin, followed by a brief summary of the features in the life history of volcanoes, whereby the subdivision is readily made into young, mature and old. This is the arrangement now used in physiography for the ready classification of any type of land form.

The remaining portions of Chapter I. deal with Characteristics of the Products of Volcanoes; Profiles of Volcanic Mountains;

Structure of Volcanic Mountains; Erosion of Volcanic Mountains; Subterranean Intrusions; and Characteristics of Igneous Rocks.

The careful reader can gain from this first third of the book the principal facts regarding volcanic phenomena, which are illustrated and applied in the later chapters dealing with the General Distribution of the Active and Recently Extinct Volcanoes of North America; Volcanoes of Central America; of Mexico; and of United States and Canada.

The last chapters are devoted to Deposits of Volcanic Dust; Theoretical Considerations; and the Life History of a Volcano.

The general reader will find every chapter full of help and interest, and the teacher will find the whole book a source of reference that should be at hand. Those who may not care to follow the theoretical considerations in a field where so much is still unknown, will find the greater part of the book well worth continuous reading. The last chapter on the Life History of a Volcano appeals to the imagination in a way that is most helpful even to the specialist in geography. Indeed the chapter is an excellent summary of the whole book, written in such a pleasing manner that the facts abide with the reader without difficulty. By comparison the book is, on the whole, not so satisfactory as its predecessors, as the reader feels that it is more of a compilation than the monographs on Lakes and Glaciers.

The typography is clear and pleasing, and the mistakes are few and not serious. The book is very attractive in its general appearance, as well as in its content. The illustrations, which are numerous, deserve more than a word of mention, for they have been carefully selected and very clearly printed. Many of the reproductions are of phenomena not generally illustrated in text-books, and hence are especially serviceable for teachers and students. The price of the book puts it perhaps beyond the reach of the common-school teacher, which is unfortunate. It is a book to which every teacher should have access, and surely should be ranked among the books of the year chosen for a village or any library. R. E. D.

First Book of Physical Geography. By Ralph S. Tarr. The Macmillan Company, 1897, pp. 368.

Prof. Tarr's First Book in Physical Geography resembles very strongly his previous successful book entitled Elementary Physical Geography. The order of treatment is essentially the same, and the amount of attention given to the different chapters varies but very slightly. The First Book, indeed, is so little less simple than

its predecessor that one can hardly see any pedagogic reason for its existence.

The book is so inclusive that naturally no very detailed or complete consideration can be given to any one topic. The value of such a book would be much increased were there fewer topics and more consideration of those few. For instance, such a brief review as Prof. Tarr gives of the tides is very inadequate, and tends to give no clear conception of the causes of these great ocean movements. Such a topic should not be introduced if there be any danger of leaving the student befogged in his impressions, or with the feeling that he knows it all.

The maps and illustrations are an improvement over those in the preceding book; are better selected and better executed. There are very few that are clear only to the eye of the learned geographer or geologist. The typography is good and pleasing, and the printer's errors are few. Yet the book shows that its preparation was hasty, and that the author has no clean-cut images of certain topics that he considers. Such an error as that concerning the location of the magnetic pole would seem to show that the author has not outlived the effects of studying Mercator maps before he had gained a globe idea of the world.

The book is attractive and will undoubtedly have a wide circulation. The high-school teacher qualified to use either book will, however, find the Elementary Book more satisfactory in some ways.

The book of questions and suggestions that has just appeared as an addendum to the text is helpful and timely, but it does not make the book complete. We have yet to see the Elementary Physiography that will be elementary in fact as well as in name, and complete and logical as far as it goes. We were disappointed in the book in question not to find it, as had been announced, written for the upper grades of grammar schools. There is still need for such a book along the lines Prof. Tarr has followed, but arranged from the laboratory standpoint. R. E. D.

Die Verwendbarkeit von Luftballons zu Forschungszwecken in unseren Schutzgebieten. Von Otto Baschin, Assistent am Kgl. Preuss. Meteorologischen Institut. (Sonderabdruck aus Nr. 3 der Deutschen Kolonialzeitung, Jahrgang, 1898.)

This paper is an argument for the use of the captive balloon as an aid to exploration, especially in such a land as New Guinea, where navigable rivers offer a means of access to the far interior of the country. The advantage of being able to survey a broad ex-

panse of territory from an elevated point is obvious; it must be left to experience to show whether much can be done with the balloon in the densely-wooded tropical regions.

Le "Appearances of Land" nella Zona Antartica, per Arnaldo Faustini. Roma, presso la Società Geografica Italiana, Via del Plebiscito, 102. 8vo. (1898.)

Signor Faustini divides the Antarctic region, geographically, into three parts:

1. Lands, fairly well known as to their configuration.
2. Lands, the existence of which is still in doubt.
3. Parts altogether unknown.

Termination Land, reported and named by Wilkes as seen on the 16th of February, 1840, has not since been reported. Capt Nares, in the *Challenge*, in 1874, found bottom at a depth of 1,300 fathoms within 15 miles of the position assigned to Termination Land, which could not be seen even from the masthead, though pack ice and many bergs seemed to indicate the vicinity of land.

Signor Faustini concludes that Termination Land does not exist.

D'Urville's Clarie Land (Côte Clarie), is identified with Wilkes's High Land, assigned to a different position.

Several other shadowy appearances of land in the Antarctic are described, including Capt. Morrell's New South Greenland, discovered in February, 1822, and Signor Faustini thinks it desirable that navigators in those waters should lend their aid in the search for these phantoms. There can be no doubt that every voyager in the Antarctic will make his contribution to the stock of knowledge.

Stanford's Compendium of Geography and Travel. (New Issue.) North America, Vol. I. Canada and Newfoundland. By Samuel Edward Dawson, Litt. D. (Laval), F.R.S.C. Maps and Illustrations. London, Edward Stanford, 26 and 27 Cockspur Street, Charing Cross, S.W. 1897. 8vo.

Dr. Dawson presents in this volume a concise account of the physical characteristics of Canada and Newfoundland, respectively the first in rank and the oldest of British colonies; but this, he says in his preface, is not the sole object of the book. He has wished also to show why these great regions are still subject to Queen Victoria, and why the "Dominion of Canada has as fair a prospect "of continuance as any other community on the two continents of "the Western Hemisphere."

His preface ends with this declaration:

> The Dominion of Canada stands on the Western Continent for a principle—the dominant principle of the Anglo-Norman race—of steady advance in orderly self-government, growing, as the trees grow, without precipitation or even haste, but never pausing and never retrograding; therefore the Canadian people take little interest in self-appointed prophets or in doctors of destiny, but they carry on their work year by year, as duty calls, leaving the result to that controlling Power which has kept them safe in the past, and is able to do so in the future.

This is worthily said, and the reader is glad to miss, for once, the obtrusive Anglo-Saxon.

Dr. Dawson revises the boundary question and asserts that the Canadians are dissatisfied with their southern frontier line. It may well be. Few nations think they have enough.

As a composition the book deserves high praise. It gives an intelligent and sufficient account of the native races, the discovery, the settlement, the history, the resources and the development of British America, with useful bibliographical notes to each chapter.

Those who turn to it for statistical information will soon find themselves reading it for pleasure.

ACCESSIONS TO THE LIBRARY.

JANUARY–FEBRUARY, 1898.

BY PURCHASE.

Les Civilisations Tunisiennes, par Paul Lapie, Paris, 1898, 8vo; Almanach de Gotha, Gotha, 1898, 8vo; An Introduction into Geography, both Ancient and Moderne, Philip Cluverius (translated by H. Stubbs), Oxford, 1657, 8vo; Philippi Cluverii Introductio in Universam Geographiam, etc., Amstelodami, 1697, 4to; The Mogul Emperors of Hindustan, by Edward S. Holden, New York, 1895, 8vo; Kokoro: Hints and Echoes of Japanese Inner Life, by Lafcadio Hearn, Boston and New York, 1896, 12mo; The Christian Topography of Cosmas, an Egyptian Monk, translated, etc., by J. W. McCrindle, London (Hakluyt Society), 1897, 8vo; The Dictionary of National Biography, edited by Sidney Lee, Vol. 53, London, 1898, 8vo; Japan as we saw it, by M. Bickersteth, London, 1893, 8vo; Rambles and Studies in Bosnia-Herzegovina and Dalmatia, by Robert Munro, Edinburgh, 1895, 8vo; China and Her Neighbours, by R. S. Gundry, London, 1893, 8vo; An Artist's Tour, by B. Kroupa, London, 1890, 8vo; The Ancient Volcanoes of Great Britain, by Sir Archibald Geikie, London, 1897, 2 vols., 8vo; The Peasant State: An Account of Bulgaria in 1894, by Edward Dicey, London, 1894, 8vo; The Lake Dwellings of Europe, by Robert Munro, London, 1890, 8vo; Soldiering and Surveying in British East Africa, 1891–1894, by Major J. R. L. Macdonald, London, 1897, 8vo; The Two Americas, by Sir R. L. Price, London, 1877, 8vo; The Land of the Almighty Dollar, by H. Panmure Gordon, London (1892), 8vo; More about the Mongols, by James Gilmour, London, 1893, 8vo; The Growth of Freedom in the Balkan Peninsula, by J. G. C. Minchin, London, 1886, 8vo; Tahiti, the Garden of the Pacific, by Dora Hort, London, 1891, 8vo; Across the Border, or Pathân and Biloch, by Edward E. Oliver, London, 1890, 8vo; The New Siberia, by Harry de Windt, London, 1896, 8vo; The Deserts of Southern France, by S. Baring-Gould, London, 1894, 2 vols., 8vo; The Downfall of Prempeh, by Major R. S. S. Baden-Powell, London, 1896, 8vo; Thirty Years of Shikar, by Sir Edward Braddon, Edinburgh, 1895, 8vo; An Indian Eye on English Life, by Behramji M. Malabári, Westminster, 1893, 8vo; Sunshine and Storm in Rhodesia, by F. C. Selous, London, 1896, 8vo; White Conquest, by W. H. Dixon, London, 1876, 2 vols., 8vo; From the Pyrenees to the Channel in a Dogcart, by C. E. Acland-Troyte, London, 1887, 8vo; European Military Adventurers of Hindustan, 1784–1803, by Herbert Compton, London, 1892, 8vo; Through America, by W. G. Marshall, London, 1881, 8vo; Human Nature in Rural India, by R. Carstairs, Edinburgh, 1895, 8vo; With Kelly to Chitral, by W. G. L. Beynon, London, 1896, 8vo; Slavonic Provinces south of the Danube, by William Forsyth, London, 1876, 8vo; Romance of Isabel, Lady Burton, Told in Part by Herself and in Part by W. H. Wilkins, London, 1897, 2 vols., 8vo; North-Eastern France, by Augustus J. C. Hare, London, 1890, 8vo; Russian Rambles, by Isabel F. Hapgood, London, 1895, 8vo; Men, Mines and Animals in South Africa, by Lord R. S. Churchill, London, 1892, 8vo; My Canadian Journal, 1872–8, by the Marchioness of Dufferin and Ava, London, 1891, 8vo; Here and There in Italy, by Linda Villari, London, 1893, 8vo; The Land of the Dollar, by G. W. Steevens, Edin-

burgh, 1897, 8vo; Li Hungchang, by Robert K. Douglas, London, 1895, 8vo; Five Years in Madagascar, by Francis C. Maude, London (1895), 8vo; Vignettes from Finland, by A. M. C. Clive-Bayley, London, 1895, 8vo; Outre-Mer, Impressions of America, by Paul Bourget, London, 1895, 8vo; Travel and Adventure in Northern Queensland, by A. C. Bicknell, London, 1895, 8vo; Turkey and the Armenian Atrocities, by Edwin M. Bliss, London, 1896, 8vo; The Real Japan, by Henry Norman, 2d Edition, London, 1892, 8vo; Among the Cannibals of New Guinea, by S. McFarlane, London, 1888, 8vo; In and Beyond the Himalayas, by S. J. Stone, London, 1896, 8vo; Face to Face with the Mexicans, by Fanny Chambers Gooch, London, 1887, 8vo; China Past and Present, by R. S. Gundry, London, 1895, 8vo; South Eastern France, by A. J. C. Hare, London, 1890, 8vo; The Scenery of Scotland, by Archibald Geikie, 2d Edition, London, 1887, 8vo; The Story of a Dacoity, etc., by G. K. Betham, London, 1893, 8vo; Eastern Persian Irak, by A. Houtum-Schindler, London, 1896, 8vo; Memorandum on the Royal Geographical Society's New Map of Persia, by George Curzon, London, 1892, 8vo; The Pamirs and the Source of the Oxus, by George Curzon, London (1897), 8vo; Notes on the Kuril Islands, by H. J. Snow, London, 1897, 8vo; British New Guinea: Country and People, by Sir W. MacGregor, London, 1897, 8vo; Index to the Fourteen Volumes of the Proceedings of the Royal Geographical Society, New Series, 1879–1892, London, 1896, 8vo; Catalogue of the Library of the Royal Geographical Society, to Dec., 1893, compiled by Hugh Robert Mill, London, 1895, 8vo; In the Northman's Land, by Maj. A. F. Mockler-Ferryman, London, 1896, 8vo; Stanford's Compendium of Geography and Travel (New Issue): Australasia, Vol I, by A. R. Wallace, Vol. II, by F. H. H. Guillemard, London, 1893–94, 8vo; Asia, by A. H. Keene, London, 1896, 2 vols., 8vo; Africa, by A. H. Keene, London, 1895, 2 vols., 8vo; North America, Canada and Newfoundland, by S. E. Dawson, London, 1897, 8vo.—Italy, from the Alps to Mount Etna (edited by T. A. Trollope), London (1888), 4to; East and West, by Sir Edwin Arnold, London, 1896, 8vo; Sir Samuel Baker: A Memoir, by T. D. Murray and A. Silva White, London, 1895, 8vo; From Everglade to Cañon, 1836–1875, by Theo. F. Rodenbough, New York, 1875, 8vo; De Zieke Reiziger, or Rambles in Java and the Straits, London, 1853, 8vo; On Dutch Waterways, by G. Christopher Davies, London (1886), 4to; The Vikings of Western Christendom, A. D. 789 to A. D. 888, by C. F. Keary, London, 1891, 8vo; The Chronicle of James I, King of Aragon, translated by John Forster, London, 1883, 2 vols., 8vo; Gheel, the City of the Simple (by Mrs. William Pitt Byrne), London, 1869, 8vo; Tenerife and Its Six Satellites, by Olivia M. Stone, London, 1887, 2 vols., 8vo; Syrian Stone-Lore, by C. R. Conder, London, 1886, 8vo; A Lady's Cruise in a French Man-of-War, by C. F. Gordon Cumming, Edinburgh, 1882, 2 vols., 8vo; Ancient Stone Implements, Weapons and Ornaments of Great Britain, by John Evans, New York, 1872, 8vo; South Africa, by J. Stanley Little, 2d Edition, London, 1887, 8vo; Histoire Abrégée des Traités de Paix, par C. G. de Koch et F. Schoell, Bruxelles, 1837–1838, 4 vols., 4to; Cositas Españolas, by Mrs. Harvey, 2d Edition, London, 1875, 8vo; Map of the State of New York, Simeon De Witt, Surveyor General, Boston, 1802, 6 sheets; Map of the District of Maine, Massachusetts, Osgood Carleton, Boston, 1802, 4 sheets; Map of Massachusetts Proper, Osgood Carleton, Boston, 1802, 4 sheets; The London Catalogue of Books, 1810–1831, London, 1831, 8vo; The London Catalogue of Books, 1831–1855, London, 1855, 8vo; The English Catalogue of Books, 1835–1863, London, 1864, 8vo; Du Tonkin aux Indes, par le Prince Henri d'Orléans, Paris, 1898, 4to; The Jesuit Relations and Allied Documents, edited by Reuben Gold Thwaites, Vols. XI, XII, XIII and XIV, Cleveland, 1898, 8vo; Golden Alaska: A Complete Account to Date of the Yukon Valley, by Ernest Ingersoll, Chicago and New York, 1897,

16mo; Klondike, a Manual for Gold-Seekers, by Charles A. Bramble, New York (1897), 16mo; The Races of Afghanistan, by H. W. Bellew, Calcutta, 1888, 8vo; The Land of Ararat, London, 1893, 8vo; The Garden of India, or Chapters on Oudh History and Affairs, by H. C. Irwin, London, 1880, 8vo; The Turks in India, by H. G. Keene, London, 1879, 8vo; Events in the Taeping Rebellion, reprints of MSS. copied by General Gordon, edited by A. 'Egmont Hake, London, 1891, 8vo; Voyages d'Alex.dre Mackenzie dans l'Intérieur de l'Amérique Septentrionale, etc., traduits de l'Anglais par J. Castéra, Paris, An X—1802, 3 vols., 8vo; Recueil de Cartes, Plans et Vues relatifs aux Etats-Unis et au Canada, 1631–1731, A.-L. Pinart (Editor), Paris, 1893, folio; Galerie Américaine du Musée d'Ethnographie du Trocadéro, E. T. Hamy, Paris, 1897, 2 parts, folio; A Chorographical and Statistical Description of the District of Columbia (by D. B. Warden), Paris, 1816, 8vo; Le Mexique Tel Qu' Il Est, par Emmanuel Domenech, Paris, 1867, 12mo; Two Years in Oregon, by Wallis Nash, New York, 1882, 12mo; Hours of Exercise in the Alps, by John Tyndall, New York, 1872, 12mo; Andrée: Au Pôle Nord en Ballon, par H. Lachambre et A. Machuron, Paris (1897), 16mo; The Land of the Midnight Sun, by Paul B. Du Chaillu, New York (1888), 2 vols., 8vo; Bermuda, a Colony, a Fortress and a Prison, London, 1857, 8vo; Our Hundred Days in Europe, by O. W. Holmes, Boston, 1887, 8vo; Historical and Biographical Atlas of the New Jersey Coast, T. T. Price, T. F. Rose and H. C. Woolman, Philadelphia, 1878, 4to; Year Book of British Columbia and Manual of Provincial Information, by R. E. Gosnell (with maps in case), Victoria, B. C., 1897, 8vo; Travels from Moscow, by Nicolai Karamsin, London, 1803 (3 vols. in 1), 8vo; The Rob Roy on the Baltic, by J. Macgregor, 9th Edition, London, 1892, 8vo; The Miracle Play of Hasan and Husain, by Sir Lewis Pelly, London, 1879, 2 vols., 8vo; Schliemann's Excavations, by Dr. C. Schuchhardt, translated by Eugénie Sellers, London, 1891, 8vo; An Account of Shelley's Visits to France, Switzerland and Savoy, by Charles I. Elton, London, 1894, 8vo; Our Home in Aveyron, by G. C. Davies and Mrs. Broughall, London, 1891, 8vo; Economic Geology of the United States, by R. S. Tarr, New York, 1894, 8vo; Sources of the Constitution of the United States, by C. Ellis Stevens, New York, 1894, 8vo; Impressions of Turkey during Twelve Years Wanderings, by W. M. Ramsay, London, 1897, 8vo; Deutscher Kolonial-Atlas, von Paul Langhans, Gotha, 1897, folio; Historical Collections of Georgia, by George White, New York, 1854, 8vo; Collections of the Georgia Historical Society, Vol. III, Savannah, 1873, 8vo; China: Political, Commercial and Social, by R. Montgomery Martin, London, 1847 (2 vols. in 1), 8vo; Tchay and Chianti, or Wanderings in Russia and Italy, by W. St. Clair Baddeley, London, 1887, 8vo; Narrative of the Wesleyan Mission in Jamaica, by Peter Duncan, London, 1849, 8vo; The Canadian North-West, etc., by G. Mercer Adam, Toronto, 1885, 8vo; History of the British West Indies, by Bryan Edwards, 5th edition, London, 1819, 5 vols., 8vo, and Atlas and Plates, 1818, 4to; Letters on Yellow-Fever, Cholera and Quarantine, by Alexander F. Vaché, New York, 1852, 8vo; The History of the Anglo-Saxons, by Sharon Turner, Paris, 1840, 3 vols., 8vo; Atlas Geographus, London, 1711, 4to; Retrospect of Western Travel, by Harriet Martineau, London, 1838, 3 vols. 12mo; The American Coast Pilot, by Edmund M. Blunt, 17th Edition, New York, 1854, 8vo; History of the Indian Tribes of Hudson's River, by E. M. Ruttenber, Albany, 1872, 8vo; Natural Selection and Tropical Nature, by A. R. Wallace, London, 1895, 8vo; Sir Walter Ralegh, by Martin A. S. Hume, London, 1897, 8vo; Everyday Life in Turkey, by Mrs. W. M. Ramsay, London, 1897, 8vo; Sir Walter Ralegh, by John Buchan, Oxford, 1897, 8vo; Twenty Years on the Saskatchewan, by the Rev. William Newton, London, 1897, 8vo; Gold Fields of the Klondike, by John W. Leonard, London (1897), 8vo; Pioneers of the Klondike, by

M. H. E. Hayne and H. West Taylor, London, 1897, 8vo; Klondyke: Truth and Facts of the New El Dorado, by A. E. Ironmonger Sola, London (1897), 8vo; Korea and Her Neighbors, by Isabella Bird Bishop, New York, 1898, 8vo; A Students' History of the United States, by Edward Channing, New York, 1898, 8vo; Seven Years in Sierra Leone, by Arthur T. Pierson, New York (1897), 12mo; South American Sketches: A Visit to Rio Janeiro, etc., by Thomas W. Hinchcliff, London, 1863, 8vo; Delagoa Bay, by Rose Monteiro, London, 1891, 8vo; Observations on the Ancient and Present State of the Islands of Scilly, etc., by William Borlase, Oxford, 1756, 4to; La Crète Ancienne et Moderne, par Charles Laroche, Paris, 1898, 18mo; The Ancient Egyptian Doctrine of the Immortality of the Soul, by Alfred Wiedemann, New York, 1895, 8vo; Chronicles of Border Warfare, by Alexander S. Withers, Clarksburg, Va., 1831, 8vo; Through Holland, by Charles W. Wood, London, 1877, 8vo; Buddhism, its History and Literature, by T. W. Rhys Davids, New York, 1896, 8vo.

BY GIFT.

From S. P. Avery:

Voyage à la Nouvelle Galles du Sud, à Botany Bay, au Port Jackson, en 1787, 1788, 1789, par John White; Traduit de l'Anglais, par Charles Pougens, A Paris; An 3 (1795), 8vo; Antwerpia (coloured plan of the City, 16th Century), s. l., s. a., sheet; Amstelredamum (coloured plan of the City, 16th Century), s. l., s. a., sheet; Amsterdam, view, London, 1814, sheet; Fridtjof Nansen (Swedish Medal, bronze), Marco Polo (bronze Medal) Nona Riunione degli Scienziati Italiani, Venezia, 1847.

From L. J. Burpee, Secretary, Ministry of Justice, Ottawa:

Regulations governing Placer Mining, Provisional District of the Yukon, Ottawa, 1898, 8vo (2 copies); The Klondike Official Guide, by Wm. Ogilvie (with map by W. I. Jennings), Toronto, 1898, 8vo.

From General J. Watts de Peyster:

Mandalay to Momien, by John Anderson, M.D., etc., London, 1876, 8vo.

From Frederick G. Jackson, London:

Map of Franz Josef Land, showing Journeys and Discoveries of Frederick G. Jackson, Leader of the Jackson-Harmsworth Expedition, 1894–7 (London), 1897, sheet.

From S. P. Langley, Secretary of the Smithsonian Institution, Washington:

The Smithsonian Institution, 1846–1896, edited by George Brown Goode, Washington, 1897, 8vo.

From Jules Leclercq, Author:

Voyage aux Volcans de Java, 1895.—Bruxelles, 1897. (Reprint.)

From Townsend MacCoun, Author:

The Holy Land in Geography and in History, New York, 1897, 2 vols., 16mo.

From the Northern Pacific Railroad:

The Klondike Gold Fields. Map of Alaska.

From the Pacific Steam Whaling Company, San Francisco, Cal.:

Pacific Steam Whaling Company's Map of Alaska, San Francisco (1897), sheet.

From E. L. Plumb:

Tratado de Limites entre Los Estados-Unidos Mexicanos y Honduras Britanica (Edicion Oficial), México, 1897, square 8vo.

From Harold Raasloff:

Voyage d'Exploration en Indo-Chine, 1866–1868, par Francis Garnier, Paris, 1873, 2 tomes, 4to, Atlas, 2 tomes, folio.

From Chandler Robbins:

Map of Alaska and Portions of the Northwest Territory, showing Routes to the Gold Fields, Chicago, 1897, sheet.

From Dr. A. Voeltzkow, Author:

Wissenschaftliche Ergebnisse der Reisen in Madagaskar und Ostafrika, 1889–1895, Frankfurt a. M., 1897, 4to.

NOTES AND NEWS.

In his forthcoming book, NORTHWARD, to be published by the Frederick A. Stokes Company about the 1st of May, Mr. Peary will tell the whole story of his work in North Greenland.

Dr. Carl Lumholtz has brought out in the *Bulletin* of the American Museum of Natural History (Vol. X, Article 1), a paper on the Huichol Indians, a tribe numbering about 4,000, living in the northwestern part of the State of Jàlisco. Their territory is about forty miles long and from twenty to twenty-five miles in width, in the heart of a very mountainous region.

There are no priests in the country, and Dr. Lumholtz says there is probably no tribe in Mexico where the ancient beliefs have been so well maintained as there.

MEETINGS OF THE SOCIETY.—On the 14th of March Dr. Titus Munson Coan will deliver a lecture on The Hawaiian Islands: the Country and the People.

At the meeting to be held April 11, Mr. Clarence Pullen will read a paper on The Mingling of the Races in Aztlan.

With the present number of the BULLETIN are printed the Charter and By-Laws of the Society, as amended.

TRANSACTIONS OF THE SOCIETY.

January–February, 1898.

The Annual Meeting of the Society was held at Chickering Hall on Monday, January 17, 1898, at 8.30 o'clock, P.M.

Vice-President Tiffany in the chair.

The following persons, recommended by the Council, were elected Fellows of the Society:

Frederick Potter.
J. Baxter Upham, M.D.
William Augustus Walker.
Edward K. Dunham, M.D.
George H. Fearons.
William B. Wait.
John A. Woods.
Samuel Untermyer.
R. P. Whitfield.
Reginald Young.
Rev. Ralph L. Brydges, Islip, N. Y.
John McAlan.
Rev. D. J. M'Millan.
W. H. Carmalt, New Haven, Conn.
Prof. Thomas L. Cottin, Darlington, S. C.
William T. Simpson.
Edward Weston, Newark, N. J.
Mrs. Frances Newbury Bagley, Detroit, Mich.
J. W. Clous, Lt.-Colonel, U.S.A.
Eugene B. Cook, Hoboken, N. J.
Rev. Francis Goodwin, Hartford, Conn.
Jacob L. Greene, Hartford, Conn.
Robert J. Hubbard (Life), Cazenovia, N. Y.
Homer N. Lockwood.
Prof. Henry Ferguson (Life), Hartford, Conn.
Prof. James M. Hoppin, D.D., New Haven, Conn.
Solomon Lincoln, Boston, Mass.
Harold P. Goodnow (Life), Fort Snelling, Minn.
Hon. John A. King (Life).
D. W. Thompson.
Joseph Obermeyer.
A. Beekman Cox, Cherry Valley, N. Y.
Samuel Swett Green, Worcester, Mass.
Prof. William H. Burr.
Charles H. Miller, M.D.
James M. Lamberton, Concord, N. H.
William Beer, New Orleans, La.
Mrs. Frederic Goodridge.
Paul Eve Stevenson, Germantown, Pa.
Edwin S. Marston.
George R. Schieffelin (Life).
B. Lowenstein.
James W. Davidson, Tamsui, Formosa, Japan.
Richard Hodgson, Boston, Mass.
Rev. Horatio Oliver Ladd, Jamaica, N. Y.
Adolph W. Magerhans.
Theodore A. Blake, New Haven, Conn.
J. C. Bancroft Davis, LL.D., Washington, D. C.

The Annual Report of the Council was presented and read:

To the American Geographical Society:

The Council respectfully submits the following Report for the year 1897:

The number of Fellows on the 1st of January was 1,069. The number added during the year was 147. The losses by death, resignation, etc., were 77, and the total fellowship on the 31st of December was 1,139, of which number 294 were Life Fellows.

The finances of the Society continue to be in a healthy condition. For details of receipts and expenditures reference is respectfully made to the report of the Treasurer, herewith submitted. The house now occupied by the Society is too small for its needs and is not fire-proof; the funds do not, however, as yet warrant the purchase of land and the erection of a suitable building thereon.

On the 3d of April the Council, by unanimous vote, awarded the Cullum Geographical Medal to Fridtjof Nansen, for his voyage in the *Fram*, and his sledge journey in the unknown polar sea to 86° 14′ N., MDCCCXCIII–MDCCCXCVI.

It has been decided to issue the Society's Bulletin hereafter five times a year, viz.: February 28, April 30, June 30, October 31 and December 31. There will be no change in the form of the publication.

The additions to the Library number 3,494, viz.: Books 794, Pamphlets and Periodicals 2,475, Atlases 14, Maps and Charts 211.

All of which is respectfully submitted.

(Signed) HENRY PARISH,
Chairman.

NEW YORK, Jan'y 8, 1898.

The report of the Treasurer was then presented and read:

REPORT OF THE TREASURER FOR THE YEAR 1897.

GENERAL FUND.

To the American Geographical Society:

The Treasurer respectfully reports that on January 1, 1897, the cash on hand, pertaining to the General Fund amounted to		$2,131.90
During the year the income was:		
From Fellowship Dues	$9,800.00	
From Invested Building Fund	9,249.37	
		19,049.37
		$21,181.27
The expenditures were:		
For Salaries	4,880.63	
" Publications	2,479.17	
" Library	1,237.41	
" Meetings of the Society	848.50	
" House and Insurance	693.50	
" Stationery, Postages and Sundries	528.55	
Transferred to Building Fund	8,000.00	
		18,667.76
On December 31, 1897, the balance on hand was		$2,513.51

NEW YORK, Dec. 31st, 1897.

WALTER R. T. JONES,
Treasurer.

The Committee charged with the duty of selecting candidates for the offices to be filled reported the following:

REPORT OF THE NOMINATING COMMITTEE FOR 1898.

To the American Geographical Society:

The Committee appointed by the Council December 4th, 1897, to nominate suitable persons to fill the offices which will become vacant in January, 1898, respectfully recommend the election of the following named gentlemen:

For President—CHAS. P. DALY, LL.D., term to expire January, 1899.
For Vice-President—EGBERT L. VIELE, term to expire January, 1901.
For Treasurer—WALTER R. T. JONES, term to expire January, 1899.
For Recording Secretary—ANTON A. RAVEN, term to expire January, 1901.
For Councillors—LEVI HOLBROOK,
MORRIS K. JESUP,
GUSTAV E. KISSEL,
HENRY PARISH,
JOHN A. HADDEN,
Terms to expire January, 1901.

(Signed) HENRY HOLT,
S. NICHOLSON KANE,
CHANDLER ROBBINS,
Nominating Committee.

On motion, duly seconded, Mr. Clinton Roosevelt was authorized to cast the vote of the Society for the candidates and they were declared duly elected.

The Chairman then introduced Prof. D. Cady Eaton, who read a paper entitled, From Cairo to Beni Hassan.

On motion, the Society adjourned.

A Regular Meeting of the Society was held at Chickering Hall on Monday, February 14, 1898, at 8.30 o'clock P.M.

Vice-President Moore in the chair.

The following persons, recommended by the Council, were elected Fellows of the Society:

William Salomon.
Arthur H. Hearn.
Harry D. Kohn.
J. Gordon Emmons.
F. C. Cross, Luling, Texas.
Charles H. Sheldon.
Charles Dudley Warner, Hartford, Conn.
W. M. Rexford.
Gen. William H. Seward, Auburn, N. Y.
Howard W. Preston, Providence, R. I.
James Schouler, LL.D., Boston.

W. A. Wadsworth, Geneseo, N. Y.
Walter Thompson, Garrison, N. Y.
Osborn Marcus Curtis.
George Watkinson, Philadelphia.

Alfred C. Harmsworth, of London, was elected an Honorary Member, and Frederick G. Jackson, of London, a Corresponding Member, of the Society.

The Chairman then introduced Mr. Cosmos Mindeleff, who read a paper on the Origin of the Cliff Dwellings.

On motion, the Society adjourned.

A Special Meeting of the Society was held at Chickering Hall, on Monday, February 21, 1898, at 8.30 P.M.

President Daly in the chair.

The following persons, recommended by the Council, were elected Fellows of the Society:

C. M. Wales, J. B. Reynolds.

The President introduced the speaker of the evening, Dr. Benjamin Howard, who described his observations and impressions during a visit to the Siberian island of Sakhalin.

On motion, the Society adjourned.

CHARTER OF INCORPORATION.

GRANTED APRIL 13, 1854.

The People of the State of New York, represented in Senate and Assembly, do enact as follows:

SECTION 1. George Bancroft, Henry Grinnell, Francis L. Hawks, John C. Zimmerman, Archibald Russell, Joshua Leavitt, William C. H. Waddell, Ridley Watts, S. De Witt Bloodgood, M. Dudley Bean, Hiram Barney, Alexander J. Cotheal, Luther B. Wyman, John Jay, J. Calvin Smith, Henry V. Poor, Cambridge Livingston, Edmund Blunt, Alexander W. Bradford, and their associates, who are now or may become hereafter associated for the purposes of this act, are hereby constituted a body corporate by the name of "The American Geographical and Statistical Society," for the purpose of collecting and diffusing geographical and statistical information.

§ 2. For the purposes aforesaid, the said Society shall possess the general powers and privileges, and be subject to the general liabilities, contained in the third title of the eighteenth chapter of the first part of the Revised Statutes, so far as the same may be applicable, and may not have been modified or repealed; but the real and personal estate which the said Society shall be authorized to take, hold, and convey, over and above its library, and maps, charts, instruments, and collections, shall not at any time exceed an amount the clear yearly income of which shall be ten thousand dollars.

§ 3. The officers of said Society shall be a president, three vice-presidents, a corresponding secretary, a recording secretary, a librarian, and a treasurer, and such other officers as may from time to time be provided for by the by-laws of the said Society.

§ 4. The said Society, for fixing the terms of admission of its members, for the government of the same, for changing and altering the officers above named, and for the general regulation and management of its transactions and affairs, shall have power to form a code of by-laws, not inconsistent with the laws of this State, or of the United States, which code, when formed and adopted at a regu-

lar meeting, shall, until modified or rescinded, be equally binding as this act upon the said Society, its officers, and its members.

§ 5. The Legislature may, at any time, alter or repeal this act.

§ 6. This act to take effect immediately.

STATE OF NEW YORK, } *ss.:*
Secretary's Office. }

I have compared the preceding with the original law on file in this office, and hereby certify the same to be a correct transcript therefrom, and of the whole of said original law.

[L. S.] Given under my hand and seal of office, at the city of Albany, this thirteenth day of April, one thousand eight hundred and fifty-four.

A. G. JOHNSON,
Deputy Secretary of State.

AMENDED CHARTER.

PASSED APRIL 8, 1871.

STATE OF NEW YORK, NO. 237, IN SENATE. *March* 7, 1871.—Introduced with unanimous consent, by Mr. Bradley; read twice, and referred to the Committee on Literature; reported favorably from said committee, and committed to the Committee of the Whole.

CHAP. 373.

AN ACT in relation to The American Geographical and Statistical Society.

PASSED April 8, 1871.

The People of the State of New York, represented in Senate and Assembly, do enact as follows:

SECTION 1. The name or corporate title of the said Society shall hereafter be The American Geographical Society of New York.

§ 2. The object of the said Society shall be the advancement of geographical science; the collection, classification and scientific arrangement of statistics, and their results; the encouragement of explorations for the more thorough knowledge of all parts of the North American continent, and of other parts of the world which may be imperfectly known; the collection and diffusion of geographical, statistical and scientific knowledge, by lectures, printed publications, or other means; the keeping up of a correspondence with scientific and learned societies in every part of the world, for the collection and diffusion of information, and the interchange of books, charts, maps, public reports, documents, and valuable publications; the permanent establishment in the city of New York of an institution in which shall be collected, classified, and arranged, geographical and scientific works, voyages and travels, maps, charts, globes, instruments, documents, manuscripts, prints, engravings, or whatever else may be useful or necessary for supplying full, accurate, and reliable information in respect to every part of the globe, or explanatory of its geography, physical and descriptive; and its geological history, giving its climatology, its productions, animal, vegetable, and mineral; its exploration, navigation, and commerce;

having especial reference to that kind of information which should be collected, preserved, and be at all times accessible for public uses in a great maritime and commercial city.

§ 3. The power given by the act hereby accorded to the said Society, to take, hold, convey, manage, and make use of its real and personal estate, shall be understood as authorizing said Society to take and hold by gift, grant, bequest, devise, subject to all provisions of law relative to devises and bequests by last will and testament, or purchase real estate to the value of three hundred thousand dollars, and to invest its income, or its personal estate generally, so as to produce a regular annual income sufficient for the accomplishment of the purposes set forth in the first section of this act; but said annual income shall not exceed twenty-five thousand dollars annually.

§ 4. The said Society shall make an annual report of its proceedings to the Legislature.

STATE OF NEW YORK, }
Office of Secretary of State. } *ss.:*

I have compared the preceding with the original law on file in this office, and do hereby certify that the same is a correct transcript therefrom, and of the whole of said original law.

Given under my hand and seal of office, at the city of Albany, this twenty-
[L.S.] second day of May, in the year one thousand eight hundred and seventy-one.

DIEDRICH WILLERS, JR.,
Deputy Secretary of State.

LAWS OF NEW YORK.

CHAP. 650.

AN ACT allowing the American Geographical Society of New York to take and hold a larger amount of real and personal property than under previous acts relating to that Society.

BECAME a law May 13, 1895, with the approval of the Governor. Passed by a two-thirds vote.

The People of the State of New York, represented in Senate and Assembly, do enact as follows:

SECTION 1. The American Geographical Society of New York may hereafter take and hold by gift, grant, purchase, devise or bequest, subject, except in the matter of income, to all provisions of law relative to devises and bequests by last will and testament,

real and personal property to the amount of one million dollars, and any income therefrom accruing, for the uses, purposes and objects of the said society.

§ 2. This act shall take effect immediately.

STATE OF NEW YORK, }
Office of the Secretary of State. } *ss.:*

I have compared the preceding with the original law on file in this office, and do hereby certify that the same is a correct transcript therefrom and of the whole of said original law.

JOHN PALMER,
Secretary of State.

BY-LAWS

OF THE

AMERICAN GEOGRAPHICAL SOCIETY.

AS AMENDED OCTOBER 23, 1897.

THE following By-Laws are hereby established as the rules and ordinances of the American Geographical Society, and all other By-Laws, Rules and Regulations heretofore made are hereby repealed.

CHAPTER I.

MEMBERSHIP.

1. The Society shall consist of Fellows and of Honorary and Corresponding Members.

2. Honorary Members shall be chosen on acconnt of their distinction in the science of geography, or of statistics, and not more than three of them shall be elected in any one year.

3. Corresponding Members shall be chosen from those who communicate valuable information to the Society and who have promoted the knowledge of geography, or of statistics.

4. Fellows, Honorary Members and Corresponding Members shall be elected by the Society as follows: All nominations of candidates shall be made in writing at a meeting of the Council by a member thereof. The names of persons thus nominated, if approved by the Council, shall be recommended to the Society for election at its next stated meeting.

5. The name of any Fellow or Member of the Society may, on the recommendation of the Council and by vote of a majority of the members present at a stated meeting of the Society, be dropped from the list; and the name of any Corresponding Member may be dropped from the list by vote of the Council, without reference to the Society.

CHAPTER II.

INITIATION FEE AND ANNUAL DUES.

1. Each Fellow of the Society shall, immediately on election, pay an initiation fee of ten dollars, which shall be considered to include his annual dues for the current year.

2. The annual dues of each Fellow thereafter shall be ten dollars, payable in advance on the 1st of January.

3. Any Fellow of the Society, not in arrears, may commute for life all dues, by the payment at one time of one hundred dollars.

4. The name of any Fellow of the Society who has neglected for two successive years to pay the annual dues, or who at any time refuses to pay them, may, by the Council, be dropped from the list.

5. The fiscal year of the Society shall be the calendar year commencing January 1, and ending December 31.

6. Honorary and Corresponding Members shall be exempt from payment of initiation fee and annual dues.

CHAPTER III.

OFFICERS.

1. The officers of the Society shall be a president, three vice-presidents, a foreign corresponding secretary, a domestic corresponding secretary, a recording secretary, a treasurer and fifteen councillors; and these together shall form the Council of the Society.

2. All the officers above-named shall be elected by the Society at its annual meeting.

3. No one shall be voted for, for any office, unless he has been nominated by the Council, or unless his nomination, made in writing by at least nine Fellows of the Society, has been conspicuously posted in the office of the Society for ten days prior to the date of the Annual Election.

4. The president and treasurer shall each be elected for one year and until their successors have been elected; and at each annual meeting there shall be elected one vice-president, one secretary, and five members of the Council, each for the term of three years and until their successors have been elected.

5. All officers to be elected may be voted for on one ballot.

6. Any Fellow of the Society, who has been such for twenty days and who is not in arrears for dues, shall be entitled to vote at the annual election.

CHAPTER IV. .

ANNUAL MEETING.

1. The annual meeting of the Society shall be held on the second Monday in January, or on any other day which may be designated by the Council for the purpose.

2. At the annual meeting the Council shall present a report of the proceedings of the Society during the past year, and the treasurer shall present his annual report.

CHAPTER V.

MONTHLY AND SPECIAL MEETINGS.

1. The Society, unless it is at any time specially ordered otherwise by the Council, shall hold a stated meeting for the transaction of business on the second Monday of each month except July, August, September and October.

2. The president, or, in his absence or incapacity, one of the vice-presidents, may, and upon the written request of the Council or of twenty-five members of the Society shall, call a special meeting of the Society by giving three days' notice thereof in two daily newspapers published in the city of New York.

CHAPTER VI.

ORDER OF BUSINESS.

1. At stated meetings of the Society the order of proceedings shall be:

Reading of the minutes.
Reports and communications from officers of the Society.
Communications from the Council.
Reports from committees.
Election of members.
Miscellaneous business.
Papers and Addresses.

2. All propositions presented to the Society at any meeting, for action, shall be in writing. A proposition thus presented, when seconded, shall be deemed to be in possession of the Society and open for discussion, but may be withdrawn by the mover at any time before amendment or decision.

3. No member shall speak more than five minutes, nor more than once, upon the same question, until all other members present have had an opportunity to be heard, nor more than twice on any question, unless leave is specially granted by the Society.

CHAPTER VII.

QUORUM.

1. At meetings of the Society nine members present shall constitute a quorum.

CHAPTER VIII.

COMMITTEES.

1. Each committee authorized by the Society shall consist of three members, who shall, unless otherwise ordered, be appointed by the chairman.

CHAPTER IX.

PRESIDING OFFICER.

1. At all meetings of the Society, on the arrival of the appointed hour and the presence of a quorum, the president, or, in his absence, one of the vice-presidents, or, in the absence of all of these officers, a Fellow of the Society shall take the chair and call the meeting to order.

2. The chairman shall have only a casting vote. He shall preserve order and decide all questions of order, subject to an appeal to the Society. At every annual meeting, before the opening of the polls, he shall appoint two tellers of the election. In case of a contest, he may declare the election postponed to the next meeting, in order that a corrected poll list may be prepared by the secretary and verified by the Council; but only one such postponement shall be made.

CHAPTER X.

SECRETARIES.

1. It shall be the duty of the Foreign Corresponding Secretary to conduct the correspondence of the Society with individuals and associate bodies in foreign countries.

2. It shall be the duty of the Domestic Corresponding Secretary to conduct the correspondence of the Society with individuals and associate bodies in the United States.

3. In case of vacancy in the office of either of the corresponding secretaries, or in the absence or disability of either of these officers, the duties of either may be performed by the other secretary, or by the librarian.

4. The secretaries shall keep in books at the rooms of the Society copies of all letters written by them, and shall file at the said rooms all letters received by them on behalf of the Society.

5. At each stated meeting of the Council they shall respectively report their correspondence, and read the same or such parts thereof as may be required.

6. The Council may designate a particular officer, or appoint a

committee, to prepare a letter or conduct a correspondence on any special subject.

7. It shall be the duty of the Recording Secretary to give due notice of all meetings of the Society and to attend the same. He shall keep adequate minutes of the proceedings of the Society. He shall give immediate notice to officers and committees of all votes, orders, resolves, and proceedings affecting them or pertaining to their respective duties. He shall at each annual election hand to the tellers a list of the members of the Society entitled to vote. He shall have charge of the seal of the Society and of the charter, by-laws, records and general archives, except so far as they may be placed by the Council in charge of others. He shall sign and affix the seal of the Society to all diplomas, deeds or other documents authorized by the Society or Council.

8. All documents in charge of the secretaries shall be kept at the rooms of the Society, unless otherwise specially ordered by the Council.

CHAPTER XI.

TREASURER.

1. The Treasurer shall have charge of all deeds, contracts, bonds, certificates, securities and muniments of title belonging to the Society. He shall collect all dues to the Society and keep the funds safely deposited in some incorporated bank or trust company approved by the Council.

2. Funds so deposited shall be drawn out only by check of the Treasurer, countersigned by the chairman of the Council, or by such other officer as may be designated by the Council for that purpose,

3. The Treasurer shall, prior to the annual meeting of the Society, prepare and submit to the Council for audit a detailed account of his receipts and disbursements during the past year, which account, duly audited and approved, he shall present to the Society at the annual meeting.

CHAPTER XII.

COUNCIL.

1. The Council shall have the management and control of the affairs, property, library, and funds of the Society, and shall transact all such business of the Society as is not required to be transacted by the Society at a stated meeting. It shall designate a bank or trust company in the city of New York in which the funds shall be

deposited by the treasurer. It shall have charge of and edit all the publications of the Society.

2. It may adopt rules for its own goverment, not inconsistent with the charter and by-laws of the Society, and appoint such standing and special committees as it may deem proper, and define their duties. It shall appoint the librarians, clerks and other servants of the Society, and fix the powers, duties, privileges and compensation of each. But no appointment shall be made which shall not be revokable at the pleasure of the Council.

3. It shall have power to fill for the unexpired term any vacancy that may occur in its own body or in any of the offices of the Society, and it may declare a vacancy to exist in any office whenever the incumbent thereof is, by reason of absence or otherwise, incapable of performing its duties. It shall have power to declare vacant the seat of any member of its own body (except the president and vice-presidents), who shall have been absent from its meetings for three successive months.

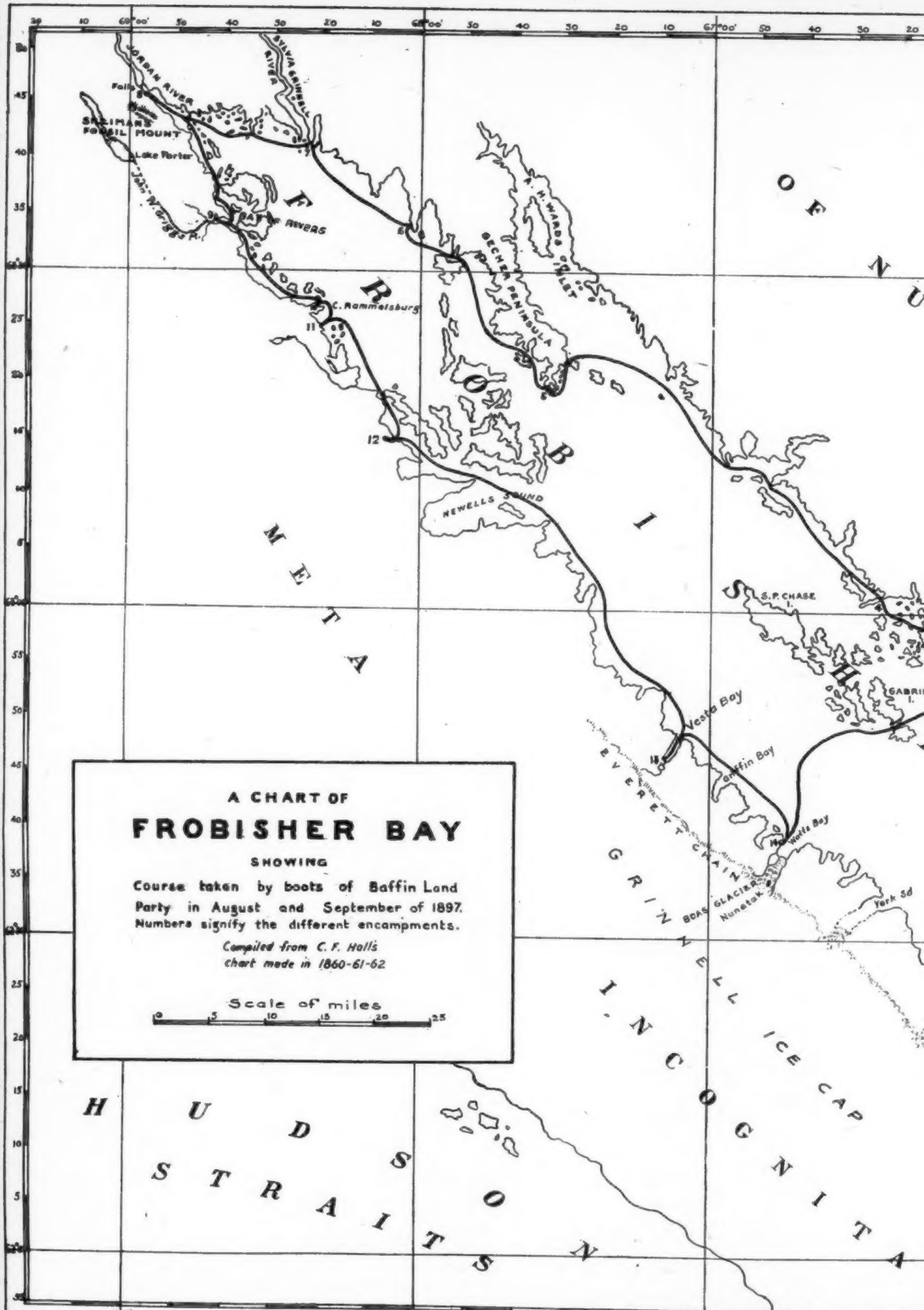
4. The Council may for good cause remit the annual dues of any Fellow of the Society.

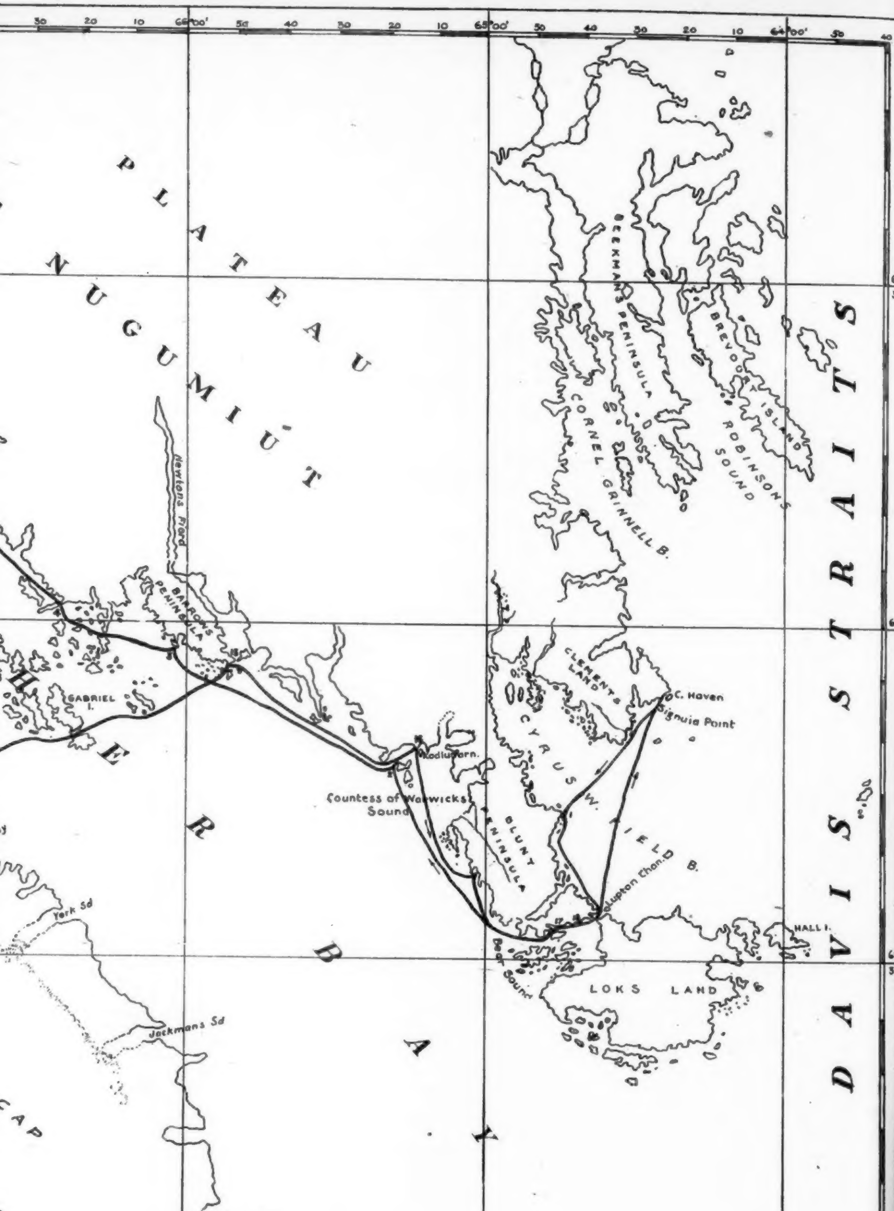
5. No member of the Council shall, directly or indirectly, receive any salary or pecuniary compensation for his services to the Society.

CHAPTER XIII.

ALTERATION OF BY-LAWS.

No alteration in these by-laws shall be made, unless proposed in writing at a stated meeting of the Society and referred to the Council for consideration, and approved by the Council and adopted by the Society at a subsequent meeting.


A CHART OF
FROBISHER BAY
SHOWING
Course taken by boats of Baffin Land Party in August and September of 1897.
Numbers signify the different encampments.
Compiled from C. F. Hall's chart made in 1860-61-62
Scale of miles
0 5 10 15 20 25
FROBISHER
OF
NU
META
INCOGNITA
HUDSON STRAITS
GRINNELL ICE CAP
EVERETT CHAIN
JORDAN RIVER
SYLVIA GRINNELL RIVER
SILLIMANS FOSSIL MOUNT
Lake Porter
Falls
BAY OF RIVERS
C. Rammelsburg
A. H. WARDS INLET
BECHER PENINSULA
NEWELLS SOUND
S. P. CHASE I.
Vesta Bay
Baffin Bay
Howells Bay
BOAS GLACIER
Nunatak
York Sd
69°
68°
67°
Longi



PLATEAU
NUGUMIUT
Newtons Fiord
BARRONS PENINSULA
GABRIEL I.
Kodlunarn.
Countess of Warwicks Sound
BLUNT PENINSULA
CYRUS W. FIELD B.
CLEMENTS LAND
C. Haven
Signuia Point
Clupton Chan.
BEEKMANS PENINSULA
CORNEL GRINNELL B.
BREVOORT ISLAND
ROBINSONS SOUND
LOKS LAND
HALL I.
Bear Sound
York Sd
Jackmans Sd
DAVIS STRAITS
RESOLUTION I.
Longitude 66° west from Greenwich.
65°
64°